VEGETATION SURVEY OF GONAREZHOU NATIONAL PARK, ZIMBABWE

FINAL REPORT

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August 2012

On behalf of
Frankfurt Zoological Society
Gonarezhou Conservation Project
Gonarezhou National Park
Chiredzi,
Zimbabwe

And
Zimbabwe Parks and Wildlife Management Authority
Harare
Zimbabwe

CONTENTS

ABBREVIATIONS

CANOCO	Canonical Correspondence Analysis
CESVI	Cooperazione e Sviluppo (Italian Cooperation and Development)
FZS	Frankfurt Zoological Society
GIS	Geographical Information System
GLTFCA	Great Limpopo Transfrontier Conservation Area
GNP	Gonarezhou National Park
TWINSPAN	Two Way Indicator Species Analysis
WWF	World Wide Fund for Nature
ZNPWMA	Zimbabwe Parks and Wildlife Management Authority

ACKNOWLEDGEMENTS

All aspects of this study have benefitted from the willing support of the Zimbabwe Parks and Wildlife Management Authority (ZPWMA) and the Frankfurt Zoological Society (FZS), and which were critical to its success.

Our daily movements and survival in the field was facilitated by the continuous and watchful care of various Gonarezhou National Park (GNP) rangers including Simbarashe Chigowe, Milton Chimuti, Farai Madhomo, Johnson Manyakara, Definite Mlambo, Oras Moyo (verification trip) and Stephen Zuva. Senior ZPWMA staff were consistent in welcoming us to the GNP and facilitating our work through sharing ideas and data making necessary introductions, providing accommodation where possible and workshop support as needed, as well as seconding the above rangers to assist us in our programme. In this respect we are particularly thankful to Norman Monks (Area Manager Chipinda Pools), Mr. Evious Mpofu (Area Manager Mabalauta/Chipinda Pools), Daniel Sithole (Senior Wildlife Officer, Chipinda Pools), Edson Gandiwa (Senior Ecologist, Chipinda Pools), Patience Zisadza (Senior Ecologist, Chipinda Pools) and Andrew Gondo (Senior Wildlife Officer, Mabalauta).

We are similarly grateful to Elsabe and Hugo van der Westhuisen of FZS for overall support to the study, for willingly sharing their camp space, providing a vehicle, fuel and other logistical support, and for enabling an over flight of the Mabalauta region. Julius Shimbani, also of FZS, proved an enthusiastic, knowledgeable and conscientious field companion with whom it was a great pleasure and privilege to work together with.

Regarding the field work, we thank Clive Stockil for guiding and accompanying us to Machiniwa Pan and in the process sharing his tremendous knowledge of the area. We also thank Vivienne Jedeikin for her cheerful participation on the initial sampling trip, for improving the quality of our dietary intake, and for taking on the roll of trip photographer.

Numerous people contributed to the conceptualization of this study, through sharing their ideas and relevant data. In this respect we particularly thank Bruce Clegg, David Cumming, Raoul du Toit Kevin Dunham, Ian Games (particularly for sharing GIS data), Mary Lovemore, Fay Robertson, and Jonathan Timberlake.

We are grateful to Christopher Chapano for services rendered in terms of plant identifications, staff members of the National Herbarium for assistance with data entry, and to Richard Owen for identifying of our rock samples.

We particularly thank Elsabe van der Westhuisen for her continued support throughout all aspects of the study, including her remarkable patience in finalizing it. We thank the FZS for providing the necessary funding to carry out this work.

DISCLAIMER

Although this study would not have been possible without the support received from Zimbabwe Parks and Wildlife Management Authority and the Frankfurt Zoological Society, the opinions and views expressed in this report remain the sole responsibility of the authors and do not necessarily reflect official views or policies of either Frankfurt Zoological Society or the Zimbabwe Parks and Wild Life Management Authority.

SUMMARY

This report documents the results of a vegetation survey of Gonarezhou National Park (GNP) and Malapati Safari Area carried out during 2010. The existing vegetation map for the GNP was produced during the 1970s, but was largely reliant on field work carried out during the 1950s. The objective of the present study was to provide an updated description and accompanying map of vegetation types within the GNP, paying particular attention to the current status of the vegetation. It is intended that this information should serve to inform a wide array of management actions, including the management of plant and wildlife communities and the placement of management and tourism infrastructure.

The methodology followed was based on and intended to be compatible with that used for the communal lands survey carried out by Timberlake et al. (1993). This comprises a phytosociological approach whereby emphasis is placed on the floristic composition of woody species rather than on vegetation structure. Sampling was targeted to distinct vegetation communities that were clearly recognizable on satellite imagery and/or in the field. A plotless method was used for each sample. Recording was primarily focused on the woody vegetation (species and structure) although the main herbaceous species were also noted. Additional information was gathered on environmental parameters and various aspects of disturbance to the vegetation.

Sampling was carried out over the period March to July 2010. A total of 330 samples were achieved, which for the total study area of 5,179 km^2 equates to a sample intensity of one sample to every 16 km^2. More than 10,000 georeferenced photographs were recorded during the sampling process. Following the initial classification and mapping of vegetation types a field verification exercise was carried out during October 2011. Based on the verification results the initial classification and mapping were extensively revised to produce the final product.

Plant identifications were carried out at the National Herbarium in Harare. A total of 493 plant species comprising 333 woody species and 160 herbaceous species were recorded. This included four new records for Zimbabwe (*Commiphora schlechteri, Croton steenkampianus, Putterlickia verrucosa* and *Gardenia* sp. c.f. *cornuta*) and twelve new records for southern Zimbabwe. Fifteen of the recorded species, within Zimbabwe, are confined to the south of the country, with nine of them being recorded only from the GNP. An additional six species within Zimbabwe are known only from Gonarezhou and the immediately adjacent area to the east of the Save River from Mahenye to Chisumbanje. None of the species are endemic to Zimbabwe. Twentyfour of the recorded species are classified as red data species within Zimbabwe, including four species classified as critically endangered (*Commiphora neglecta , Periploca nigrescens*, *Rinorea elliptica* and *Schotia capitata*), two endangered species (*Adenium multiflorum* and *Milicia excelsa*) and five vulnerable species (*Acacia exuvialis*, *Adenia fruticosa* subsp. *simplicifolia*, *Manilkara concolor*, *Pachypodium saundersii* and *Suregada zanzibariensis*). Fourteen exotic species were recorded, most notably *Lantana camara* which is an aggressive invader and extremely difficult to eradicate.

All data from the field sheets were entered into a Microsoft Access database. Classification of samples was carried out manually, but was additionally informed by a series of computer based classifications using TWINSPAN and MULVA packages running on the platform JUICE. Based on species composition and environmental variables the 330 samples were classified into 9 main classess (Types 1 - 9) comprising 27 vegetation types and 10 subtypes. Four additional types with limited distributions were recognized (Types 10 and 11), to give a total of 41 types and subtypes. Descriptions of the vegetation types were prepared according to a standard format.

Mapping was based on the interpretation of Landsat and Google Earth satellite imagery and was informed by the location and classification of the sample points together with the georeferenced photographs. Various computer based classifications were attempted but were discarded in favour of

direct on-screen digitizing. In addition to the 41 vegetation types and subtypes, three further units were mapped (river beds, dams and cultivation), to give a total of 44 map units.

The distribution of vegetation types was largely consistent with underlying geology. The bulk of the GNP is covered by Cretaceous sedimentary deposits known as the Malvernia Beds. To the north and south there are sizeable occurrences of basalt and intermediate acid intrusive rocks, with small portions of alluvium along the major drainages.

The vegetation of the Malvernia Beds on the upland sandy areas consists primarily of *Guibourtia conjugata* dominated woodlands or derived secondary woodlands (Types/Subtypes 1.1, 1.1.1, 1.1.2, 1.2 and 1.3), with the lower lying areas with heavier soils supporting various types of *Colophospermum mopane* woodland (Types/Subtypes 4.5, 4.6, 4.6.1, 4.7. 4.8 and 4.8.1). There are additional localized occurrences of miombo woodland (Types 2.1, 2.2 and 2.3), *Androstachys johnsonii* woodland (Types/Subtypes 8.3, 8.4 and 8.4.1), *Spirostachys africana* woodland in depressions (Type 3.1), plus two special types of restricted distribution (Types 11.1 and 11.2)

The northern granophrye portion comprises a mosaic of two main woodlands types: the bulk on lighter textured soils on hills and flat ground comprising a woodland type originally dominated by *Brachystegia tamarindoides* subsp. *torrei* (Type 5.1), plus one subtype type dominated by *Millettia usaramensis* subsp. *australis* (Type 5.1.1), and on heavier textured soils in depressions a mixed woodland type and one associated subtype (Type 6.1 and Subtype 6.1.1). Along the southern rim of the granophyre area there is an irregular belt of *Colophospermum mopane* woodland (Type 4.2). On the granite portion to the extreme northeast there are two confined occurrences of a similar type of *Brachystegia tamarindoides* subsp. *torrei* woodland (Type 5.2), plus a mixed Combretaceae dominated secondary woodland type (Type 5.3). In addition there are numerous small patches of *Androstachys johnsonii* woodland on rocky hill tops (Type 8.1) and *Combretum apiculatum* woodland on some of the steeper slopes (Type 7.1). The basalt plains to the north of the Park are dominated by *Colophospermum mopane* woodland, plus a subtype along drainages (Type 4.1 and Subtype 4.1.1).

The vegetation on the igneous complex in the southwest of the Park is dominated by *Androstachys johnsonii* dominated woodlands (Type 8.2 and Subtype 8.2.1), togeher with *Colophospermum mopane* woodland (Types/Subtypes 4.1, 4.1.1, 4.3 and 4.4), and *Combretum apiculatum* woodland (Type 7.2). There are additional small occurrences of *Spirostachys africana* woodland in depressions (Subtype 3.1.1), plus two special types of restricted distribution on rhyolite hills (Types 10.1 and 10.2).

Mixed alluvial woodland (Type 9.1) was encountered wherever there were alluvial deposits, particularly along the Mwenezi, Runde and Save River but also along the lower reaches of some of the larger tributaries to the Runde River. In places small patches of heavier textured alluvium supported a particular type of *Colophospermum mopane* woodland (Type 4.9).

Many of the constituent vegetation types, within Zimbabwe, are virtually unique to the GNP. In this respect the 13 types and four subtypes identified from the Malvernia Beds, plus the four types and two subtypes from the northern granophyre intrusion, and the four special restricted subtypes, can all be considered as national conservation priorities. Although riparian woodlands occur widely throughout the country and adjacent regions, the portion around the Save-Runde junction comprises one of the largest remaining and relatively intact portions in the country, and is already formally recognized as comprising one of 20 Important Bird Areas in Zimbabwe.

Despite high conservation significance, the bulk of the vegetation throughout the Park is highly degraded. There has been a massive reduction of trees, with upper canopy trees, in particular, having been virtually eliminated or greatly reduced over large areas. Many of the remaining large trees have serious bark damage and/or have been reduced to the level of the subcanopy or even the shrub layer, whilst many of the younger trees are multitrunked from having been knocked or burned down to ground level, probably repeatedly, and then resprouted. In many stands relatively high numbers of

dead trees were observed. Despite high levels of degradation of vegetation resources the physical environment has remained relatively intact, with only localized occurrences of sheet and gully erosion, presumably because most of the terrain is virtually flat or gently undulating.

The cause of the tree reduction appears to be due to elephants acting in concert with fire. As elephants knock down large trees this creates conditions for increased grass production which leads to more frequent and hotter fires, which further reduces the woody vegetation, so resulting in the progressive reduction of woodlands to open woodlands or even grasslands. During the present survey evidence of elephant damage to woody vegetation and of burning were widespread throughout the Park. Elephant densities have been sustained at relatively high levels since about 1970, although prior to 1992/93 elephant populations were kept in check largely through culling. Since then there has been steady growth, to the extent that the total elephant population is now higher than ever recorded, with the overall density approaching two animals per km^2.

The continued reduction of woodland by elephants and fire comprises a critical threat to the future conservation of plant biodiversity within the GNP. In the absence of intervention the present observed trends can be expected to persist, leading to the loss of certain plant species and the further modification of vegetation types to states from which they may not readily recover. Such large scale changes to habitats will inevitably impact on many animal populations. In order for the GNP to fulfill its conservation objectives this situation needs to be addressed as a matter of urgency. Reduction of elphants should be accompanied by a fire management programme, the aim of which would be to limit the occurrence of high intensity fires that are most damaging to woody vegetation.

The implementation of elephant exclusion zones is reccommended as an immediate but temporary stop gap measure to protect the remaining best preserved stands for vegetation types of high conservation priority. It is also suggested that the existing vegetation monitoring programme should be revised and strengthened according to the results of this survey. Additional efforts should be made to limit the spread of alien plants, particularly *Lantana camara* but also *Opuntia* species.

1. INTRODUCTION

1.1 Background

The southeast lowveld of Zimbabwe comprises relatively arid and inhospitable terrain. The principal economic activities are irrigated agriculture, livestock production and wildlife production. The most frequent livelihood activity, however, is subsistence cropping, although this is not sustainable and requires perennial subsidization principally in the form of food aid.

The Gonarezhou National Park (GNP or the Park) is situated between the Mwenezi and Save Rivers and alongside the international border with Mozambique. It covers some 5,000 km^2 of the most marginal and inhospitable terrain within the southeast lowveld. In addition to being an important part of the protected area system in Zimbabwe, Gonarezhou is an essential component of the wildlife and tourism industry in the southeast lowveld.

Although the Park could feasibly serve as a powerful driver of economic and social development within the lowveld region this has never yet been achieved. In the face of numerous challenges, investment, the development of infrastructure, numbers of visitors and the generation of income have remained consistently low. In line with the national economic collapse, conditions during the preceding decade were particularly difficult.

In recent years there has been renewed interest in the Park, principally due to efforts to establish the Great Limpopo Transfrontier Conservation Area (GLTFCA) over a vast area straddling the boundaries between Zimbabwe, Mozambique and South Africa. Gonarezhou forms a key component of the GLTFCA, together with the Kruger National Park in South Africa and Limpopo National Park in Mozambique.

Within this context, and building on a long history of prior collaboration, the Frankfurt Zoological Society (FZS) in 2008 initiated a programme of financial and technical support to the newly reformulated Zimbabwe Parks and Wildlife Management Authority (ZPWMA), specifically to support the management and development of the GNP. Potentially, this programme will run for a period of 10 years. Key components include development of operational and administrative procedures and management systems, development of infrastructure, the development of tourism and of sustainable financing for the Park.

Sound planning and development necessarily requires a solid understanding of the natural resource base that the Park is mandated to conserve. Plant resources, in particular, are key components of habitats and primary determinants of the animal populations that directly or indirectly depend on them. Information on vegetation resources is relevant to virtually all aspects of park management including resource management and protection (biodiversity conservation objectives, special plant communities and species); the management of large herbivore populations and their habitat requirements; the development of infrastructure for management and tourism purposes, and the development of tourism activities.

There is an existing vegetation map for the GNP (Sherry, 1970) but without any accompanying descriptions of the mapped units. This is largely based on work carried out in 1959-60 in connection with tsetse fly control operations (Farrell, 1968). During the intervening 50 years there are believed to have been marked changes in the structure and composition of many plant communities within the park. The present study was commissioned by FZS specifically to provide updated and improved information on vegetation resources within the GNP, in the form of a vegetation map accompanied by descriptions of the constituent vegetation types.

1.2 Structure of the Report

The remainder of the report is divided into a further seven main sections. The following three sections provide a brief description of the GNP (Section 2), followed by a review of other relevant vegetation studies (Section 3) and a description of the methodology employed (Section 4). The main results comprising identification, description and mapping of vegetation types are presented in Section 5, with additional information on species diversity and species of interest in Section 6. Sections 7 and 8 comprise a discussion of these results and the final conclusions. These are followed by references (Section 9) and supporting appendices (Section 10).

2. STUDY AREA

An understanding of the patterns of natural resources within the GNP, as briefly detailed in this section, provides essential context to understanding the resulting distribution of plant species and vegetation communities.

Location

Gonarezhou National Park (GNP) is situated to the extreme southeast of the country, alongside the international border within Mozambique and stretching between the Mwenezi and Save Rivers (Map 1). It comprises a roughly rectangular strip some 35 to 45 km in width and some 135 km long. For the purpose of this study it was decided to include Malapati Safari Area, to the west of the Mwenezi River, thus giving a total area of 5,179 km^2.

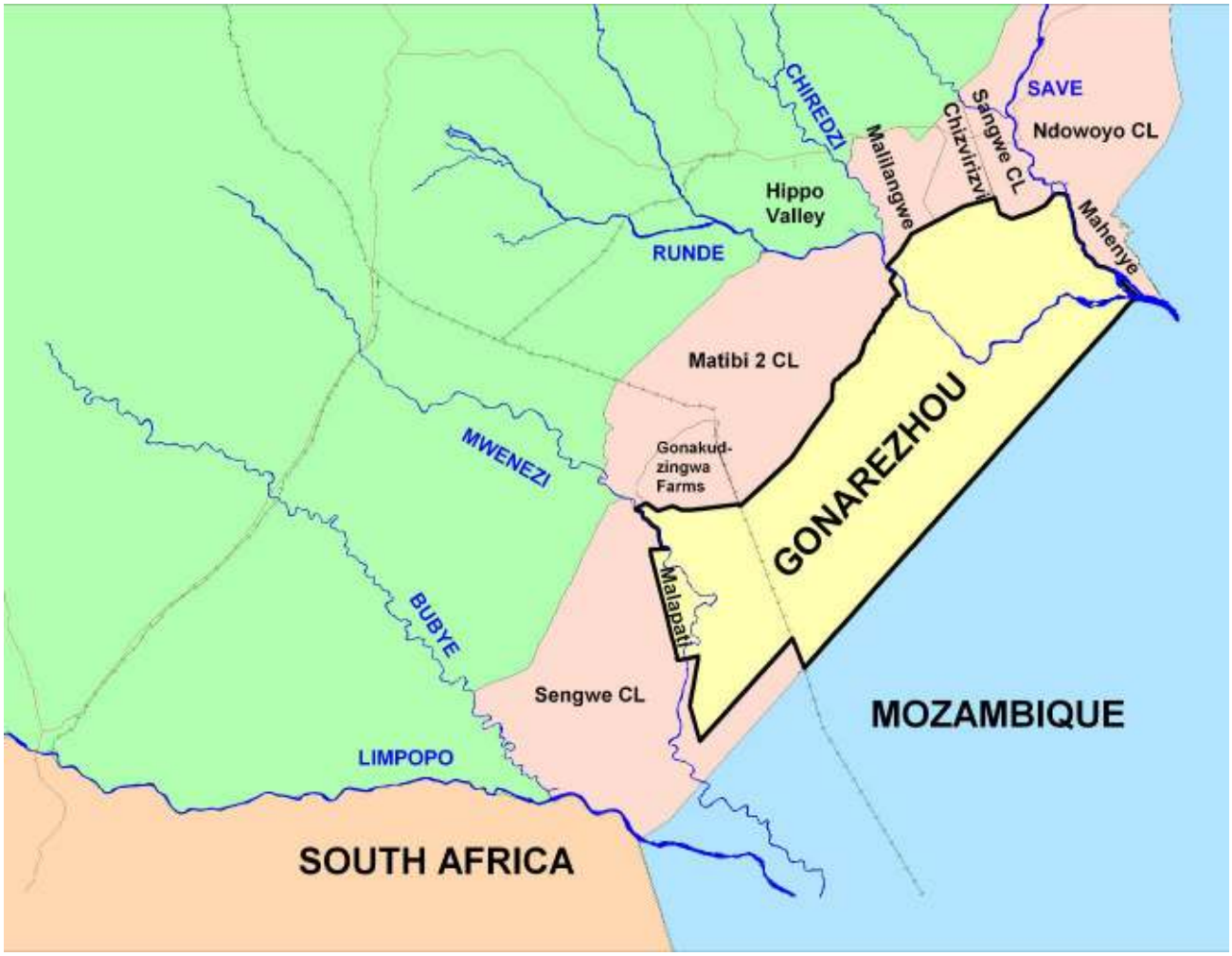
Elsewhere the boundary used was that as proclaimed in 1975, although there are now a number of discrepancies between this official statutory boundary and the de facto situation on the ground. These are partly due to the construction of a foot and mouth disease control fence around the perimeter of the park in the mid 1980s, but which was not aligned strictly along the boundary of the park. Certain portions of Sengwe and Matibi No. 2 Communal Lands were included with the park inside the fence, whilst a small portion of the park to the south of Malapati was excluded. To the north there is also an issue of recent settlement along the Gulugi drainage within the park.

Neighbouring areas to the GNP include Mahenye ward of Ndowoyo Communal Land to the east of the Save River; Sangwe Communal Land, Chizvirizvi Resettlement Area and Malilangwe Conservation Trust to the north and east of the Runde River; Matibi No. 2 Communal Land and Gonakudzingwa Small-Scale Commercial Farming Area to the north between the Runde and Mwenezi Rivers; Sengwe Communal Land to the west and south up to the railway line, and then Mozambique, continuing east from the railway line through to the Save River.

Geology

From a structural perspective the GNP is situated centrally within an area known as the Limpopo mobile belt. This comprises an extensive east-northeast trending tract of high grade metamorphic rocks, some 600 km long by 300 km wide, which lies between the Zimbabwean and Kaapvaal cratons. The portion occupied by the GNP, however, forms part of a down-faulted basin that has been subsequently filled by various more recent igneous intrusions and sedimentary deposits, such that there is no exposure of the underlying older basement rocks.

Map 1. Location of Gonarezhou National Park.



Deep basalt beds underlie the northern portion of the GNP to the north of the Chiwonja Hills, plus small patches to the south in the vicinity of the Mwenezi River Map 2). Dating from the Karoo era these are the oldest rocks in the park. Beyond the park the basalts form an almost continuous but irregular belt stretching from the Tuli Circle in the west to the Mozambiquan border to the east of the Save River.

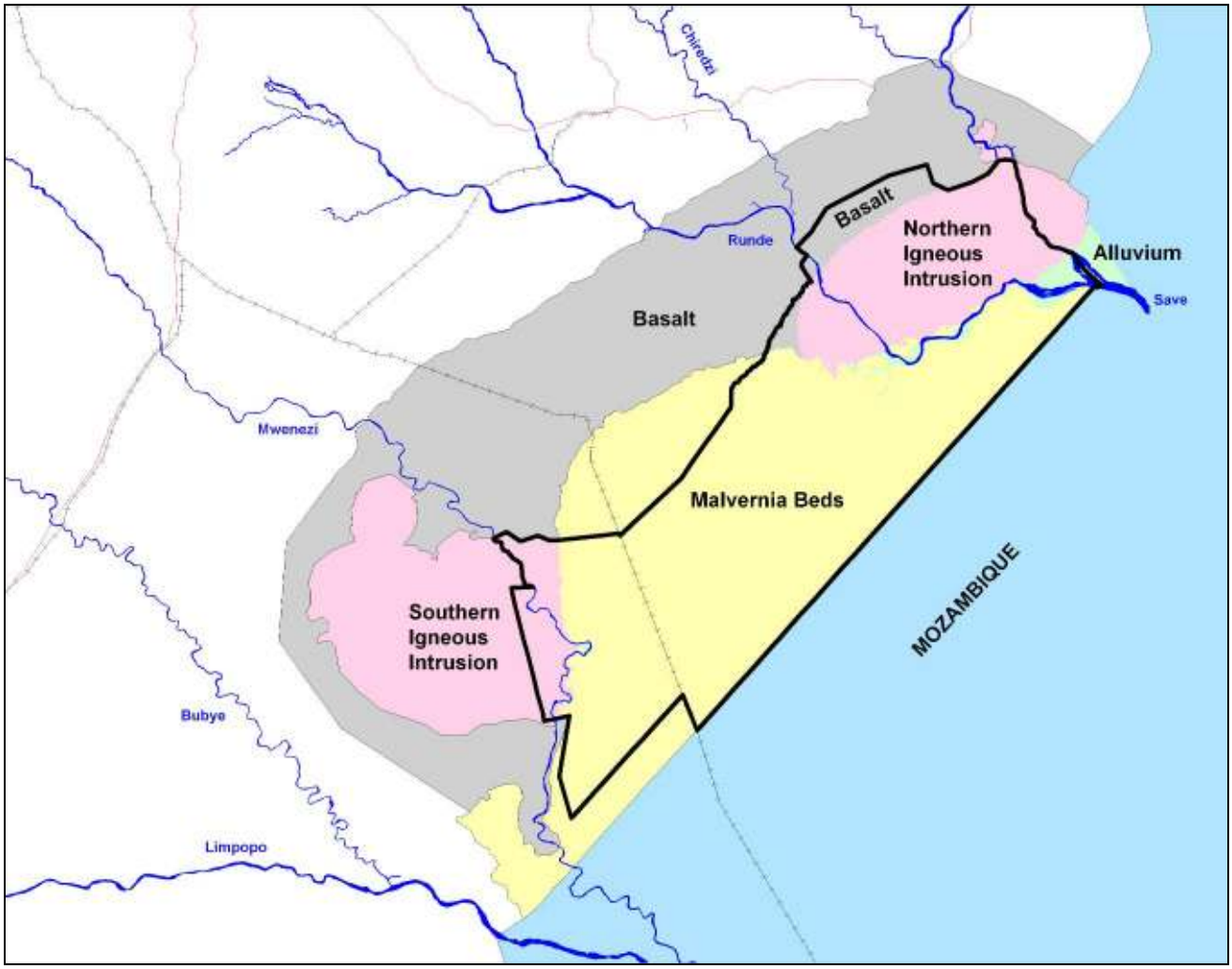
To both the north and south of the park the basalt portions have been intruded by more recent igneous rocks. To the north these occur as an oval feature extending from east of the Save River to some 15 km to the west of the Runde River. To the south of the park there is a similar circular to ovoid intrusive complex but which impinges only marginally into the study area. This covers all of Malapati Safari Area plus small portions to the east of the Mwenezi River, particularly the northwestern corner of the GNP but also a minor part to the south of Mabalauta. On the national 1:1,000,000 geological map the northern portion is mapped as granophyre (plus a little granite), and the southern occurrence as a mix of rhyolite and granite interspersed by irregular portions of basalt. However, rock samples taken during the course of the present study suggest a more complex picture, with a wider range of intermediate acid rocks being recorded from both the northern and southern intrusions, including rhyolite, microgranite, granite, trachyte, grandiorite, syenite, diorite and gabbro-diorite.

Over the central and major part of the GNP, the Karoo basalts are overlain by more recent Cretaceous sedimentary deposits known as the Malvernia Beds. These comprise a succession of gently dipping red and white sandstones, grits and conglomerates, variably cemented by calcite. These appear to have been lain down in a shallow inland lake or perhaps a deltaic or coastal environment resulting from a marine incursion from the east. They appear to be devoid of fossils. The Malvernia Beds,

within Zimbabwe, extend marginally into the adjacent Sengwe Communal Land, the Gonagudzingwa Farms and Matibi 2 Communal Land and, to the east continue into the neighbouring portions of Mozambique (Map 2).

Small areas of more recent quaternary alluvial deposits are also found, principally in the vicinity of the Save-Runde junction, but also alongside the Runde River in the vicinity of the Chilojo cliffs, and on the lower reaches of the Mwenezi River to the south of Mabalauta.

Map 2. Geology of Gonarezhou National Park and surrounding areas.



Landform and Drainage

From a geomorphological perspective the GNP forms part of the Limpopo-Save Lowlands of Zimbabwe (Lister, 1987). These extend across the southernmost part of the country between the Shashe and the Save Rivers, in the form of a relatively flat plain that rises gently to the north from the Limpopo River. This gently sloping pediplain represents the Pliocene erosion cycle. Within the park there are minor localized exposures of the earlier Post-African surface on the highest parts of the Chiwonja Hills, and of the more recent Quaternary surface along the major wide sand-bed drainages of the lower reaches of the Mwenezi (to the south of Mabalauta), Runde (to the south of the Chilojo cliffs) and Save Rivers (particularly around the Save-Runde junction).

The central portion of the GNP, underlain by the Malvernia Beds, dips gently to the southeast towards Mozambique. Eroded into this central sand plateau are a number of small valleys and stream courses, principally the Guluene and Chefu which drain directly into Mozambique and, to the east, the Madzwikota, Luvuma, Mutondowari and Nyamasikana streams that drain east towards the Runde

(Map 3). Elsewhere, particularly to the east of the railway line, there are numerous pans that occupy un-drained depressions in the surface.

The western portion is dominated by the Mwenezi drainage which extends eastwards roughly parallel to the railway line. In the vicinity of Buffalo Bend, erosion by the Mwenezi into the adjacent Cretaceous sediments has given rise to the Ntambambomvu Hills, comprising deep red coloured cliffs several kilometers long and situated some five km to the east of the Mwenezi River. Upstream of Mabalauta the Mwenezi cuts a pronounced gorge through the flanking intrusive rocks. The best developed portion, situated some five km north of Mabalauta, is known as the Samalema Gorge.

Map 3. Physical features and drainage of Gonarezhou National Park.

The basalt portions give rise to relatively flat terrain, whilst the granophyre type intrusive rocks give rise to more broken and rocky landscapes. Between the Runde and Save Rivers the Chivonja Hills form a northeast trending ridge, the highest points of which are Makamandima (578 m) and Mutandahwe (571 m). The northern scarp of the Chivonjas coincides with the contact between the granophyre and basalt, and results from the greater resistance to erosion of the more acid rocks. This same belt of resistant granophyre rock gives rise to the Silonja Hills to the west of the Runde.

The Chilojo Cliffs are the most spectacular feature within the GNP. These trend east-west for approximately 20 km immediately south of the Runde River and rise to some 180 m above the river

course to an elevation of about 380 m. South of the cliff face, the Chilojo plateau dips gently towards Mozambique to an elevation of some 340 m along the border. To the east, the Chilojo cliffs gently fade out towards the confluence of the Save and Runde Rivers. Some 12 km to the west, Nyamatongwe stands out as a prominent cliff-bounded inselberg, some seven km long by two to four km wide.

The area around the Save-Runde junction, at about 160 m elevation, is the lowest point of the country. Here there is a broad alluvial plain, prone to flooding, and with a number of prominent pans including Tembwehata between the Save and Runde Rivers and Machiniwa to the south of the Runde.

Major dams have been constructed on the upstream catchments of the Mwenezi (Manyuchi), Runde (Mutirikwi, Banagala and Manjirenji) and Save (Osborne) Rivers, which have significant impacts on downstream flow regimes including within the Park. Other streams and pans are seasonal. There are two points where permanent artificial water supplies have been developed, these being Benji Weir to the south of the Runde, and Massasanya Dam within the Pombadzi area between the Save and Runde.

Climate

The southeast lowveld is one of the hottest and driest parts of the country. Mean annual rainfall at Chipinda Pools over the 29 year period from 1961 to 1990 was 515 mm (Booth, 1991). Long term records from stations in surrounding areas vary from 483 mm per annum for Humani Ranch to 603 mm for Chisumbanje. The bulk of the rain falls between the months of November to March, with May to September being the driest months. "Guti" conditions, comprising light showers and sometimes long-lasting cold and drizzling rains occur in the winter months, such that some rain is received in practically all months of the year.

Annual rainfall is highly variable. Droughts are relatively common with occasional severe occurrences. During the 1991/92 season Mabalauta received just 76 mm of rain and Chipinda Pools only 98 mm. Such conditions can lead to significant dieback and mortality of trees and animals, with the scarcity of grazing and browsing resources typically being exacerbated through competition from large numbers of livestock that are moved into the park from surrounding areas.

Being situated along the lower reaches of large catchment areas the southeast lowveld is also prone to flooding, typically in association with cyclone conditions that occasionally penetrate deep inland from the Mozambique coast. Such floods can cause severe damage to infrastructure, a prime example being the Runde bridge at Chipinda Pools. Destroyed in 2000 by Cyclone Eline this crossing has yet to be rebuilt.

Temperatures, due to the low altitude, are notoriously high. Temperatures greater than 30^{o} C occur in all months of the year, with absolute maxima over 40^{o} C and reaching to the mid 40s being recorded for the months from September to February. Frost does occur but the occurrence of extreme "black frosts" is rare. There are occasional unseasonal occurrences of cold, wet and windy weather that can result in severe losses of life of both wildlife and livestock.

Soils

Soils of the GNP, as for most parts of Zimbabwe, are directly related to the underlying geology. Given the relatively young geology and prevailing climatic conditions the extent of weathering and leaching are relatively confined, such that soils of the southeast lowveld tend to be relatively shallow, relatively unleached and with appreciable reserves of weatherable materials, such that they are inherently fertile (Thompson and Purves, 1978, Nyamapfene, 1991).

The basalt rocks give rise to the heaviest textured soils, comprising shallow to moderately deep, reddish to dark brown or black clay to loamy clay soils. Soils of the younger intermediate intrusive

rocks are more varied, partly due to the more pronounced topography, and partly due to a reduced proportion of clay producing minerals. On uplands, broken areas and steep slopes there are relatively extensive occurrences of surface rocks and accompanying shallow lithosols. Within depressions there are localized accumulations of clay, giving rise to pockets of vertisols. Elsewhere, on relatively flat and gently sloping areas soils tend to be lighter textured clay loams/loamy clays, sandy clay loams/sandy loam clays or sandy loams/loamy sands, varying in colour from red/orange to red brown, to brown or dark brown soils.

The Malvernia Beds also give rise to a wide range of soil types, depending in part on the nature of the underlying sediments and in part on position within the landscape. The upper plateau areas are dominated by extensive patches of deep unconsolidated sands to loamy sands (regosols), typically with red to orange brown and often relatively pale colouration. Elsewhere, in lower lying areas one finds more clay-rich loam soils, varying in composition from clay-loams to sandy clay loams to loams to sandy loams/loamy sands, often with inclusions of pebbles, gravel or grits. Clays are uncommon even in localized depressions. The loamy soils tend to be moderately shallow to moderately deep, and with darker colouration (brown to red brown to dark brown) than the upland sand areas.

Alluvial soils mainly occur in association with the Mwenezi, Runde and Save Rivers. These are consistently deep and tend to be relatively heavily textured clays, loamy clays to clay loams, but with occasional occurrences of lighter textured sandier soils.

A soil survey of the GNP was carried out in 1975 by the Department of Research and Specialist Services (Purves and Fullstone, undated, in Magadza et al., 1993), but was not seen during the course of the present study.

General Vegetation

Structurally the GNP is dominated by various types of woodland, ranging from alluvial woodlands, to mopane woodlands on heavier soils on basalts, igneous intrusive rocks and parts of the Malvernia Beds, plus various *Guibourtia* and *Combretum* dominated woodlands, principally on the sandier soils of the Malvernia Beds but also covering much of the northern granophyre. There are additional localized occurrences of miombo (*Brachystegia spiciformis, B. tamarindoides* subsp. *torrei* and *Julbernardia globiflora*), *Androstachys* and *Spirostachys* woodlands to closed woodlands, plus dry forest patches (on alluvium), thickets (on the Malvernia sands), bushlands (principally scrub mopane on basalts and Malvernia Beds) and wooded grasslands (mainly on the eastern granophyre portion). Natural grasslands are virtually absent, as are *Acacia* woodlands, whilst aquatic systems are limited to the three main rivers, the two artificial dams, plus numerous small and mostly seasonal pans.

Floristically the area forms part of the Zambezian Regional Centre of Endemism (White, 1983), which includes all of Zimbabwe, Zambia and Malawi plus parts of Mozambique, South Africa, Botswana, Namibia, Angola, Democratic Republic of Congo and Tanzania.

Wildlife

The GNP supports a wide range of large herbivores and carnivores. Elephants are dominant both numerically and in terms of biomass, and thus also impact to the environment. According to results of the most recent aerial survey carried out in September 2009 (Dunham et al., 2010) the estimated elephant population was 9123 animals which equated to 1.84 elephants/km2. Other abundant species included impala (estimated population of 6005 animals), cattle (2991), buffalo (2274), kudu (2285) and zebra (1385). Common but less abundant species include eland, giraffe, nyala, waterbuck, wildebeest, warthog, duiker, grysbok, steenbok, crocodiles, hippopotamus, goats/sheep and donkeys. Trend analysis suggest that since the severe reductions that occurred during the extreme 1991/92 drought, the estimated populations of elephants, buffalo, eland, kudu, waterbuck and zebra have all

increased significantly (Dunham et al., 2010). Numbers of impala and giraffe did not show any significant trends over this same period.

Biodiversity

There are existing species lists for the GNP for plants, mammals, birds, reptiles, amphibians and fish and plants, as summarized by Magadza et al. (1993). Additional lists have been compiled for the adjacent portion of Sengwe Communal Land immediately to the east of the park, including for arachnids and butterflies (various authors, summarized in Cunliffe, 2000).

The list of 924 plant species for the GNP includes some 630 woody species (trees, shrubs and woody climbers) plus 294 herbaceous species, representing a total of 118 plant families and 364 genera (but not seen during the course of this study).

All groups show some affinity with the adjacent East African coastal plain and, to a lesser extent, the more arid areas occurring further to the west in the interior of the continent. A number of species of conservation interest have been identified for all groups, comprising endemic species, species of restricted distribution within the region, species that are relatively widespread in the region but within Zimbabwe only occur in the GNP or southeast lowveld, plus species that are considered to be rare and/or threatened in Zimbabwe.

The extensive alluvial area around the Save-Runde junction has been specifically identified as one of 20 important bird areas in Zimbabwe (Childes and Mundy, 1997). Elsewhere, the pans of the Guluene drainage are recognized as being of particular importance in that they support what appears to be an endemic fish species, the small annual turquoise killifish (*Nothobranchius furzeri*). Additional sites of conservation interest for plants and birds (four each) have been identified within the adjacent Sengwe communal land (Cunliffe, 2000).

Ecology

Magadza et al. (1993) provide an overview of the ecology of the GNP. Here, it is sufficient to briefly mention some of the more important issues, particularly those relevant to plant ecology. Key concerns include the modification, degradation and/or loss of certain plant communities, particularly through the loss of trees, apparently due to the impacts of herbivores, fires, droughts and human disturbances or a combination of such factors. Human disturbances have tended to be relatively localized, whilst droughts, herbivores and fires potentially operate across the entire landscape.

Amongst the large herbivores, elephants have repeatedly been identified as the principal agent of change. The impact of elephants and other large herbivores is related to their distribution through the park, which in turn relates to the occurrence of water supplies including the provision of artificial water supplies. The marked degradation around Benji Weir is a good example in this respect. Elephants and fire appear to act synergistically – elephants being responsible for a reduction in woody cover, which enables an increase in the herbaceous layer, which leads to more frequent and higher intensity fires, which results in a further reduction of the woody layer. These processes are believed to have contributed to the virtual elimination of *Brachystegia tamarindoides* subsp. *torrei* woodland from the Pombadzi granophyre. Other large herbivores implicated in more localized vegetation changes include hippopotamus, impala and even smaller species such as porcupine (through damage to the bark of certain trees).

Direct human disturbances have resulted through clearing for agriculture and bush clearing for the control of tsetse fly. Prior to declaration as a park, resident communities cultivated scattered fields on alluvial deposits along parts of the lower Runde River and in the vicinity of the Save-Runde junction. More recently, there has been extensive settlement and cultivation within the northern basalt plain in association with the Gulugi drainage. Mechanical bush clearing was carried out as a tsetse control

measure during the period from about 1960-64, impacting the northern portion of the Runde River to the north of the Chivilila Falls and a 16 km wide zone to the east of the Chikombedzi-Malvernia railway line.

Additional indirect human disturbances have occurred through factors such as reductions in herbivore populations, through tsetse fly control hunting operations (1964 – 1970), culling operations (mainly elephants but also hippo and impala) and poaching activities, grazing of livestock and changes to the fire regime.

The principal river systems of the GNP have been seriously impacted through upstream dam construction leading to reduced flow regimes, and upstream agricultural activities leading to marked siltation and water pollution in the form of agricultural chemicals.

3. PREVIOUS VEGETATION STUDIES

The earliest description of vegetation communities within the GNP was provided by Wild (1955) who described but did not map 12 broad vegetation types for the area between the Save and Runde Rivers. This was complimented by a similar report for the area extending north along the Save River to Birchenough Bridge, again without any mapping (Rattray and Wild, 1955).

The first detailed vegetation map for Gonarezhou was produced by Farrell in 1968. This covered an area of some 12,700 km^2, extending south from Birchenough Bridge along the Save River and, to the west, through and including the bulk of the Park up to the Chikombedzi-Sango railway line in the west. This was based on work carried out in 1959-60 in connection with tsetse fly control operations (Farrell 1959a and b, 1960a, b, c and d), both within the Park covering the western Chivonja Hills, and extending north from there outside the Park. The remaining bulk of the park was mapped by other workers (not named), and was based on the interpretation of aerial photography at a scale of 1:40,000 (as compared to 1:25,000 for the north), such that the southern portion was noted as being less reliable than that to the north. A total of 23 vegetation types were described and mapped at a scale of 1:250,000, 18 of which were represented within the Park.

Farrell's more detailed work in the western Chivonjas (1959a) covered a total area of some 325 km^2. Thirteen vegetation types were described and mapped at a scale of 1:40,000, all of which occur within the Park.

The existing vegetation map for the GNP (Sherry, 1970) is largely based on Farrell's work, with minor modifications and extended to include the portion to the west of the railway line so as to provide complete coverage for the park. This was carried out by members of the Department of National Parks and Wildlife Management, as it was then called, probably by Brian Sherry. The resulting map was never published and is variously attributed to Sherry or the DNPWLM, and as undated or 1970 or 1977. Other park ecologists who possibly contributed to this work include Richard Peek, Gary Sharpe and Ian Coulson. The resulting map, produced at a scale of 1:250,000, depicts 15 vegetation types, only one of which is confined to the west of the railway line (i.e. would not have occurred on the initial Farrell map). Unfortunately, there are no descriptions for the constituent types.

Within the park little additional vegetation mapping has been carried out since this time. Tim O'Connor produced a detailed map of a small area (4.4 km^2) near Nyahungwe as part of his M.Sc. study concerning hippopotamus-habitat relationships (O'Connor, 1982; O'Connor and Campbell, 1986). This was based on the interpretation of 1:6,250 air photos. A total of 10 vegetation types were described and mapped.

More recently Bruce 1 produced a preliminary vegetation map for the Pombadzi Wilderness Area between the Save and Runde Rivers, as part of a feasibility study regarding the possible reintroduction

of black and white rhinos into this portion of the park (Clegg, 2003 in Dunham, 2005). This was based on a desk study comprising an unsupervised classification of Landsat satellite imagery, but without any ground verification. A total of 22 vegetation units were mapped but without any accompanying descriptions.

Additional vegetation mapping and description work has been carried out in the surrounding areas, including Mahenyes Ward and Sengwe Communal Land (Mapaure and Chapano, 1999 – on behalf of CESVI) and Malilangwe (Booth, 1980; Stalmans, 1994; O'Connor, 1997, Clegg, 1999 and 2010). Other works relevant to the southeast lowveld include those carried out during various school expeditions to Mateke Hills (Boughey, 1958; Drummond, 1958, Guy, 1958), Tuli Safari Area (Boughey, 1959; Kennan and Drummond, 1959, Thompson, 1959), Sentinel Ranch (Boughey, 1960) and Maramani Communal Land (Symes, 1967); Timberlake and Mapaura's (1999) survey of the Maramani/Tuli area carried out on behalf of CESVI; plus surveys of Musikavanhu Communal Land in the middle Save (Oosterhout and Campbell, 1985) and of Senuko (Du Toit, 1989) and Sango Ranches (Hin, 2000). An updated vegetation map for the Save Valley Conservancy is currently in the process of being prepared (Robertson, in prep.).

Elsewhere, vegetation maps exist for most of the other national parks and safari areas within the country including Hwange (Rogers, 1993), Matetsi (Worsley, 1988), Victoria Falls (Hill, 1969), Chizarira (Tompson, 1976), Chirisa (Martin, Craig and Mahlangu, 1985), Sengwa (Craig and Mahlangu, 1980; Craig, 1983), part of Mana Pools (National Parks, 1975), Matopos (Grobler, 1973, 1974), Kyle (National Parks, undated; Lightfoot, 1978), Lake Chivero (Tomlinson, 1975), Chimanimani (Goodier and Phipps, 1962), Nyanga (Tomlinson, 1975), Mupfure (Scoones, 1990) and Ngezi (Conybeare, 1976), generally at a scale of 1:100,000 or larger.

From a national perspective there have been no recent surveys into which the results of the various studies listed above can be fitted. Henkel produced the first national map in 1931, principally using altitude to define vegetation zones. This was followed by Boughey (1961) who again used altitude as his mapping base, with some modifications due to major soil differences. Rattray (1961) used a physiognomic framework, according to which the country was subdivided on the basis of floristic composition, the resulting map being presented in Rattray and Wild (1961). Wild (1965) revised this substantially in the light of other studies and observations into a more detailed map. This was essentially the same as that presented in Wild and Barbosa (1968) and which remains the standard reference work for the country to this day.

More recently Timberlake, Nobanda and Mapaure (1993) carried out a survey of the communal lands to the north and west of the country. Vegetation was divided into nine physiognomic-floristic classes (moist forests, riparian forests and alluvial woodlands, dry forests and thickets, miombo woodlands, miombo-mopane woodlands, mopane woodlands, Combretaceae open woodlands, *Acacia* open woodlands and grasslands) and sub-divided into 37 types which were described and mapped. One of their objectives was to provide a structure to assist in the extrapolation of results from existing studies and to provide a framework for future studies. The intention was to extend the survey to the remaining communal lands to the south and east, but this has never materialized.

Looking further afield within the GLTFCA the most relevant studies are those covering the Kruger National Park (Gertenbach, 1993) and adjacent areas (Peel, Kruger and MacFayden, 2007) in South Africa, plus Limpopo, Zinave and Banhine National Parks in Mozambique (Stalmans, Gertenbach and Carvalho-Serfontein, 2004; Stalmans and Peel, 2010; Stalmans and Wishart, 2005). These studies have all followed a common methodology using a plot based sampling of woody vegetation, computer based classification and ordination techniques (TWINSPAN and CANOCO) and the use of Landsat imagery to guide the mapping of landscape units at a scale of 1:250,000. An important feature is that mapping is of landscape units rather than individual vegetation types, these being defined as "an area with a specific geomorphology, climate, soil, vegetation pattern and associated fauna". Each landscape unit often comprises a mixture of two or more vegetation types, and individual vegetation

types commonly occur in more than one landscape unit. Numbers of landscape units vary from five for Banhine, six for Zinave and 10 for Limpopo to 35 for the Kruger National Park, and of vegetation types from 11 for Banhine to 10 for Zinave and 15 for Limpopo.

4. APPROACH

The methodology followed for this survey was based on and intended to be compatible with that of the communal lands survey of Timberlake et al. (1993), and which has been adopted for most subsequent vegetation surveys in the country, including those carried out by WWF in the Zambezi Valley, CESVI within the southeast lowveld and the ZPWMA. This comprises a phytosociological approach whereby emphasis is placed on the floristic composition of woody species rather than on vegetation structure. Sampling was targeted to distinct vegetation communities that were clearly recognizable on satellite imagery and/or in the field. Final mapping was guided by the interpretation and classification of Landsat and Google satellite imagery. The methodology included five main stages:

- Preparatory activities
- Field sampling
- Initial analysis, mapping and reporting
- Field verification
- Final mapping and reporting

4.1 Preparatory Activities

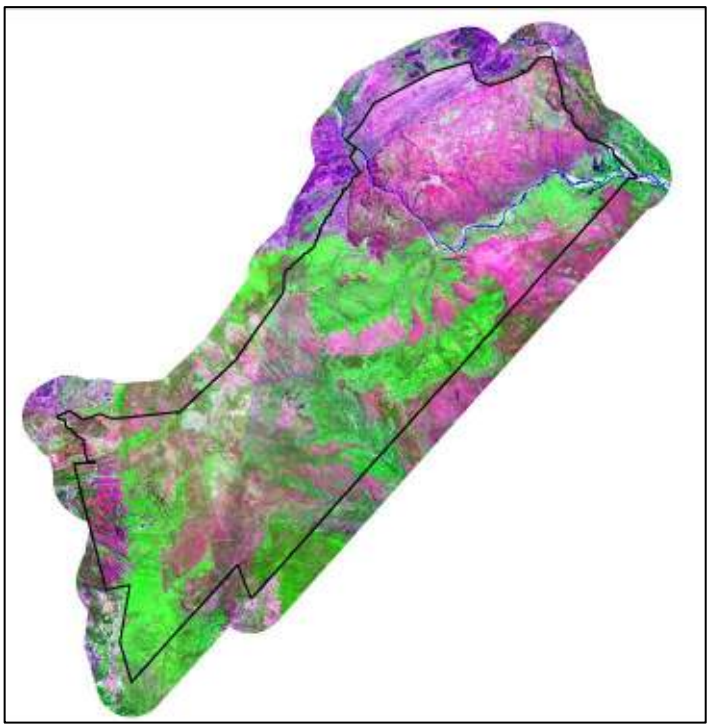
Preparatory activities carried out prior to the field trip included:

- Carrying out a literature review
- Acquisition of satellite imagery and preliminary classifications of Landsat images
- Preparation of maps for use whilst in the field
- Development of a field data sheet
- Preparation of an initial plant species list for the GNP

Literature Review. Timberlake and Nobanda's (1993) overview paper on vegetation surveys in Zimbabwe was used as the starting point for the literature review. Drawing on this an effort was made to identify, assemble and review all previous vegetation survey studies carried out within the GNP, the adjacent areas, elsewhere within the southeast lowveld of Zimbabwe, for other protected areas within Zimbabwe, national or large scale framework surveys within Zimbabwe, plus surveys carried out within other major components of the GLTFCA, notably in and around the Kruger National Park in South Africa and Limpopo, Banhine and Zinave National Parks in Mozambique. The purpose of this review was to provide a broader context for the present study and to provide guidance on the choice of methodology for the study.

Satellite Imagery. Considerable time was spent in identifying and acquiring suitable Landsat imagery. In the end it was decided to work principally with imagery from May 2000, the two relevant scenes being of excellent quality and devoid of any cloud cover or burning. Similar imagery was being used for an ongoing vegetation survey of the nearby Save Valley Conservancy, reportedly with good results (Faye Robertson, pers. comm.). Images were subject to standard processing and sharpening techniques, including contrast stretching, decorrelation, principal component analysis and various colour transformations. Different band combinations were tried and examined. In the end it was decided to principally work with a combination of Bands 543. Results of initial unsupervised classifications carried out using ENVI were not satisfactory, such that for the field work it was decided to instead work with various unclassified false colour images.

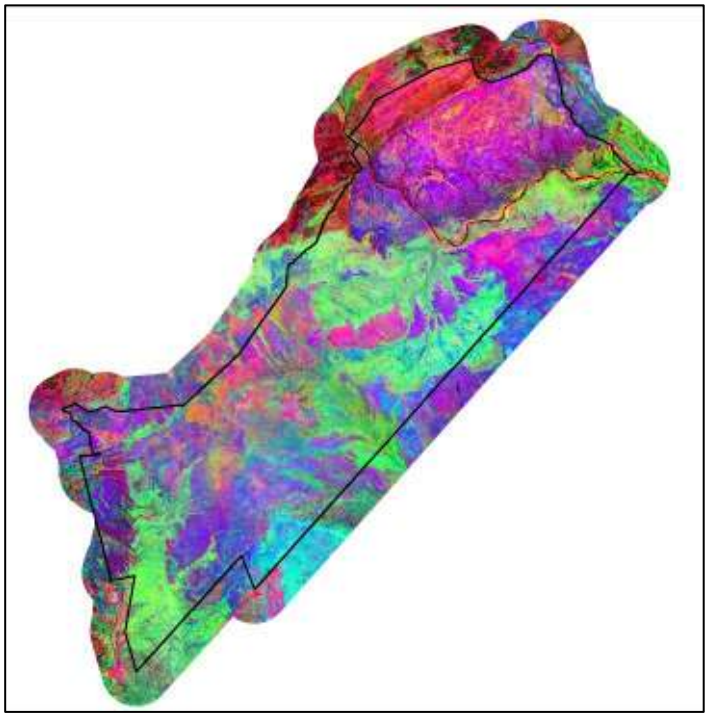
Map 4. False colour RGB image derived from May 2000 Landsat 7 ETM+ imagery using bands 5, 4 and 3.



Field Maps. A series of hardcopy A0 maps were produced and printed for use in the field. These proved essential in terms of planning the sample strategy, identifying daily sample routes and possible locations for samples, and for positioning and navigating whilst in the field. As sampling progressed each sample was marked onto the maps so as to provide a visual picture as to what had been covered and where further effort was still necessary.

Use was made of existing GIS data such as relief, geology, vegetation and the distribution of roads and tracks, together with various forms of Landsat imagery. In addition to the road network, all maps were overlain with a UTM grid, in order to facilitate positioning and navigating whilst in the field through comparison with GPS readings.

Map 5. False colour RGB image derived from principal component analysis of bands 5, 4 and 3 of May 2000 Landsat 7 ETM+ imagery.



Two series of maps were produced, one at a scale of roughly 1:230,000 whereby the GNP could be shown on a single A0 sheet, the other at a scale of approximately 1:80,000 whereby the GNP was spread across three A0 sheets. These larger maps comprised false colour RGB images based on Landsat bands 543 and on a principal component analysis for bands 543 (Maps 4 and 5). These proved the most useful ones in the field and were the ones used for planning daily routes, guiding the location of sample points and navigating. The smaller maps depicted relief, geology and existing vegetation, as well as false color images derived through decorrelation stretching, HLS, HSV and Munsell analyses of satellite imagery.

Sample Sheet. A custom data sheet was drawn up specifically for this study, based on that used by Timberlake et al. (1993) for the communal land vegetation survey, but with minor modifications based on field experience (Appendix 1). Ideally, there should have been opportunity to field test and then fine tune the data sheet prior to the start of sampling, but in the event this was not possible.

Species List. Two main sources were used in developing an initial plant species list for the GNP: a previous but incomplete listing obtained from GNP, and the computerized listing of plant specimens retained within the National Herbarium in Harare. These sources were combined, and the

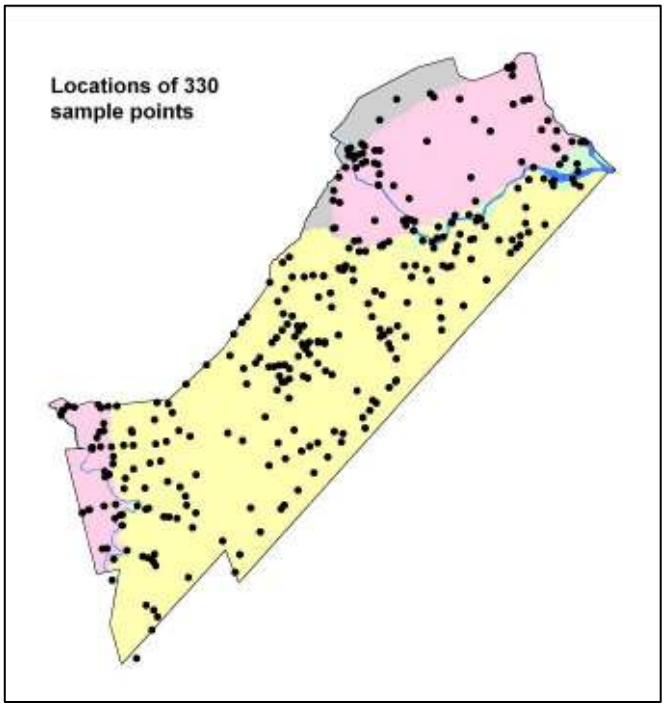
nomenclature was updated and standardized. Nomenclature used for this list and for field recording largely followed that of Mapaura and Timberlake (2004) with subsequent modifications as accepted by the National Herbarium.

The resulting list, although evidently still incomplete, contained some 491 species in 87 families. This proved an extremely useful tool whilst in the field carrying out the vegetation sampling.

4.2 Field Sampling

Three sample trips were carried out between March and July 2010. The overall sampling team comprised the consultant team of Tom Muller (TM), Anthony Mapaura (AM) and Rob Cunliffe (RC), plus Julius Shimbani (JS) of FZS, who was seconded to the team for the entire duration of the sampling. For the first week of sampling the entire team worked together as a single unit. This afforded opportunity to ensure that everyone was familiar with the sampling methodology, and to ensure reasonable consistency in scoring the various parameters by different individuals or teams. For the remainder of the initial trip the bulk of sampling was carried out by two teams, the one comprising TM and AM and the other RC and JS. For the second field trip TM, AM and JS worked as a single team, and the third was carried out by AM and JS, again as a single team.

Map 6. Location of sample points.



The number of samples achieved on each trip was 186, 123 and 21 respectively, to give an overall total of 330 samples. Altogether a total of 71 days were spent in the field, during which sampling was carried out on 63 days. For some days sampling was disrupted due to rain, or else fitted in as part of a travel day, such that only 1 or 2 samples were achieved on those days. For the remaining days each team managed between 3 and 8 samples per day, depending on factors such as the distance to be traveled by vehicle, the state of roads, distances covered on foot, complexity of the vegetation types etc. Given that two sample teams were operational over 15 days on the initial trip, the total number of "team days" was 78, giving a mean achievement of 4.2 samples per "team day". At all times sample teams were escorted in the field by one or more ZPWMA rangers who provided valuable field advice and guidance as well as armed protection.

In addition to field sampling, a single and extremely useful over flight was carried out within the Mabalauta region on March 17th together with Hugo van der Westhuisen.

During the first trip it was planned to cover the entire GNP at low sample intensity so as to get a feeling for the overall range of vegetation types. In the event, due to rains, very few samples were achieved in the Pombadzi region between the Save and Runde Rivers. At the end of the first trip, and again after the second trip, gap analyses were carried out to determine those areas and vegetation types which needed to be targeted during the subsequent sampling trips. Sampling during the second trip was focused on the eastern portion of the park, plus additional samples from the igneous rocks around Mabalauta. For the final trip sampling was carried out on foot. Four areas were specifically targeted, comprising portions that were considered to be important but had been missed out during the previous trips as they were not accessible by road.

The selection of sample sites was guided by field observations and the use of satellite imagery. For all samples a key consideration was to sample within a single type, clearly visible in the field and/or on the satellite imagery, and to keep within that type without straying across any ecological boundaries into adjacent types. Satellite imagery was used to ensure that as wide a variety of types as possible was covered, particularly for those types easily accessible by road, and also to ensure as wide a spread of samples as possible across the landscape and across different types (Map 6). For each site a way point was recorded at a central location, together with the site elevation (Appendix 2).

Data Recording

A plotless method was used for each sample and recording was primarily focused on the woody vegetation. At any sample the team would start recording woody plant species from an arbitrary point (usually some 10 to 20 m away from the road in order to avoid any possible road related disturbances), and keep moving and recording all new woody species until such time as no new species were being found. The area covered was generally about 0.5 to 2 ha.

The general location of each sample point was recorded, together with the waypoint number and corresponding GPS coordinates (recorded at a central location within the plot) and altitude (also from the GPS). Coordinates were recorded in decimal degrees, using the WGS84 datum. The date and recorder were also noted, and the sample was given a field number and, later, a final sample number.

All woody species present in the area were recorded in five height classes: seedlings, less than 0.5 m (mainly regeneration), 0.5 to 3 m (shrubs and young trees), greater than 3 m (tall shrubs and trees) and mature trees (canopy height trees). Each species in each layer was allocated a cover-abundance value using a six point scale: + = < 2%, 1 = 2 – 10%, 2 = 11 – 25%, 3 = 26 – 50%, 4 = 51 – 75% and 5 = 76 – 100%.

Recording of the herbaceous layer was confined to prominent forbs, the principal grass species and the overall herbaceous cover.

Any species which could not be reliably identified in the field was collected, labeled and later confirmed at the National Herbarium in Harare.

Environmental parameters considered relevant to the interpretation of plant distribution were recorded on the reverse of the data form. These included: landscape type (a brief description of the position of the sample within the surrounding landscape), lithology (type of underlying bed rock or superficial deposits), soil type (colour and texture), slope, aspect, presence of termitaria (size and density), proportion of bare ground and litter cover, as well as the presence of surface capping, gulley and sheet erosion. The categories used for the various parameters are shown on the sample sheet (Appendix 1). In most cases where surface rock was apparent a small sample was taken for subsequent identification in Harare. Soil texture was estimated in the field using the “sausage” technique, whereby a sample handful (taken from below the top soil at about 15 cm depth) was wetted and then rolled in the hand.

Vegetation structure was captured in the form of summary information for each apparent vegetation layer, in most cases comprising an herbaceous layer plus one or more shrub layers, plus one or more tree layers. For each layer the dominant species were recorded together with an estimate of its height and total cover (%).

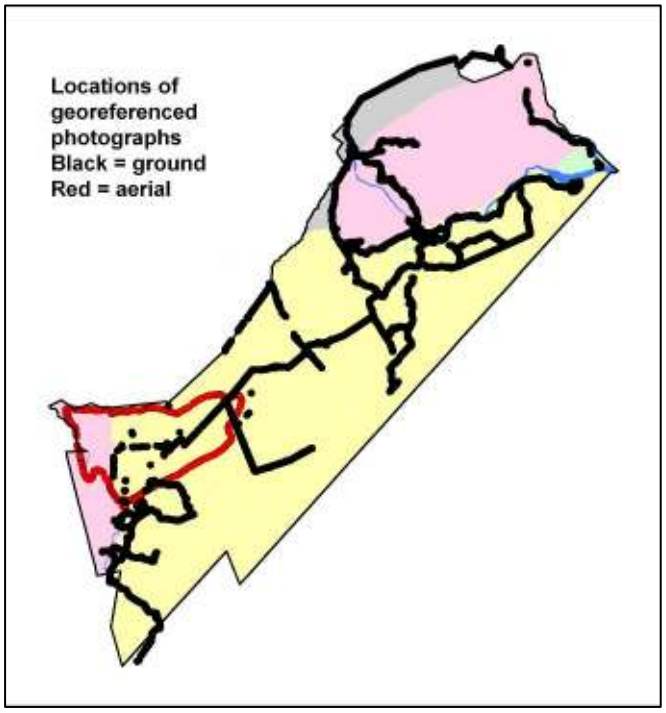
Additional data was gathered concerning evidence of disturbance to the vegetation, including the presence of any alien plant species, plus observations concerning the impacts of fire and browsing and the reduction or loss of trees. An estimate was made of the overall state of the vegetation type, based on the above factors together with consideration of the occurrence and spacing of mature trees and/or the dominant tree layer and intervening gaps between these.

Additional features of interest for each sample were captured in the form of written notes. These typically included reference to surface rocks, the presence of burning, the presence and general size of gaps in the dominant woody layer, plus a count of the numbers of canopy trees and dead trees visible from the point of recording.

Additional GPS way points were recorded at sites of particular interest, for example at points of abrupt change from one community to another, or at a point considered to be a good representative example of a certain type. A total of about 330 such points were recorded.

Extensive use was made of photography as a supporting tool, both in terms of capturing visual images of vegetation composition and state, as well as to provide reference points to be used in the subsequent mapping of vegetation communities. In addition to representative photographs recorded for each plot, numerous other photographs were taken along all routes traveled (Appendix 7). These photos were all georeferenced, to give a total of about 10,000 georeferenced photographs (Map 7).

Map 7. Locations of georeferenced photographs recorded during field sampling.



4.3 Analysis and Reporting

Back from the field, data analysis and reporting was split amongst the three key team members. AM took primary responsibility for the management and identification of plant specimens, data entry and management, and for carrying out various computer based classifications. TM undertook the classification of samples into types and writing descriptions of the types. RC was responsible for the mapping and production of the overall report.

Data Entry. The initial requirement was to confirm the identity of the numerous plant specimens collected in the field and to standardize and harmonize species names across all 330 data sheets. This was carried out by AM, working in conjunction with TM, and Christopher Chapano of the National Herbarium in Harare. The resulting lists of woody and herbaceous plant species are provided in Appendices 3 and 4. Richard Owen was contracted to identify the rock samples. The bulk of the data from the field sheets was entered into electronic format in the form of a Microsoft Access database, as described in (Appendix 7). This included all the species information and associated data captured on the front of the data sheet, plus most of the environmental, structural and status parameters recorded on the reverse. Development of the database initially lagged behind the classification process, but once in place it proved an extremely valuable resource in preparing the sample classifications and accompanying descriptions of vegetation types.

Identification and Description of Vegetation Types. TM carried out an initial classification of the 330 samples into vegetation types, based on manual comparisons of species composition and in accordance with accompanying environmental characteristics. Descriptions of each type were prepared according to a standard format. In writing the descriptions, certain samples were reclassified, some types were scrapped and new ones created.

AM carried out a parallel computer based classification process, principally using TWINSPAN and MULVA, two multivariate classification techniques. These were run from within a software platform package called JUICE, which facilitated translation of the classification results into dendrograms.

Results based on the full set of 330 samples were generally disappointing, yielding poor correspondence to the manual classification and were largely discarded. More useful results were obtained by working with subsets of the samples, for example all plots on Malvernia sands, or all the mopane woodland plots. These results were used to inform and modify the manual classification.

Similarly, the classification was run in parallel with mapping activities, leading to a similar iterative process whereby results of the classification informed the mapping and vice versa.

Mapping. Key resource materials used to guide the mapping process included Landsat imagery (Bands 543, plus PCA, DECORR, HLS, HSV and Munsell transformations, and Bands 752); Google imagery in the form of a georeferenced composite image covering the whole of the Park; the sample points, additional observation points and the georeferenced photographs.

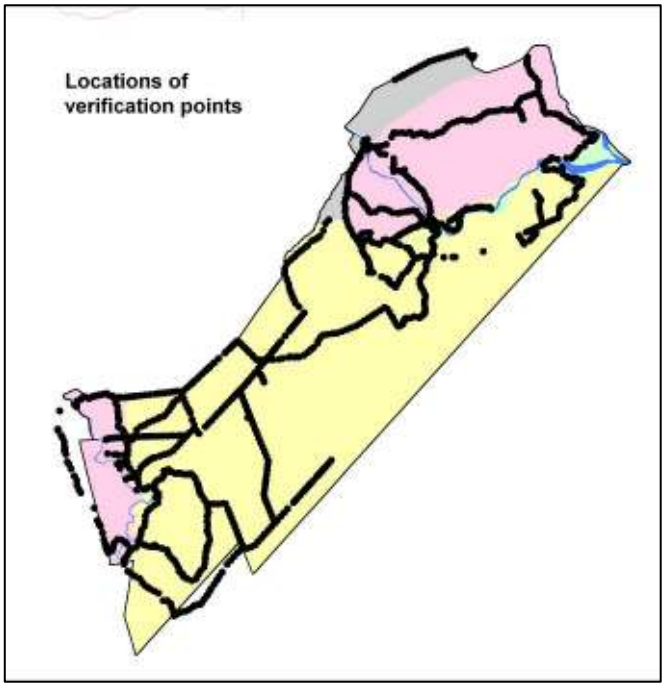
Based on the classification of the 330 samples into vegetation types, a series of supervised classifications were run using ENVI. However, these results were largely unsatisfactory in comparison to the existing classification, georeferenced photographs and additional observation points. Possible reasons for this include the fact that the identification of types was primarily based on floristic rather than structural characteristics such that each type could include a range of structural representations; the high levels of disturbance that were observed throughout the Park, including apparent invasion by secondary species which could be expected to blur differences between vegetation types, and the fact that 2000 (the year of the Landsat imagery) was an abnormally wet year, which would have resulted in unusually high herbaceous cover for all types, and which again may have blurred the distinction between some types.

The bulk of the mapping was instead carried out by a visual interpretation of the satellite imagery which was captured through on screen digitizing. The mapping process started with delineation of the most obvious features, such as the principal rivers and the boundaries between the major geological types, and cultivated portions. The work proceeded gradually to the most difficult types, this being delineation of the various sand and mopane woodland types on the Malvernia Beds. As for the classification of vegetation types, this was an iterative process with results from the plot classification informing the mapping and vice versa. However, the overall approach was to map the units recognized from the classification of the sample points, rather than leading with delineation of map units and seeking to fit the samples to identified map units.

4.4 Field Verification

The purpose of the field verification exercise was to test and evaluate the draft vegetation map. This was carried out over a two week period during October 2011. Test points were taken whilst driving through the Park by comparing what was observed in the field against the type shown on the map. This was achieved by connecting a GPS to a notebook computer such that it was possible to follow ones progress and location in real time on the draft vegetation map as one was travelling. It was attempted to cover as much of the existing road network as possible. The resulting coverage is shown in Map 8. Sample points were taken at one km intervals using the vehicle odometer, with a point being recorded immediately at the start of each km. Additional waypoints were recorded, for example, where passing through a narrow belt (< 1 km) of a type that would otherwise not have been recorded. For some points it was possible to assess the vegetation type from the vehicle, in other cases it was necessary to get out and walk around and make a more thorough assessment of species composition. A total of 987 sample points were recorded. An additional 131 way points were recorded with accompanying notes, for example, noting the boundary from one type to another.

Map 8. Locations of verification points.



4.5 Final Classification, Mapping and Reporting

Based on the results of the verification exercise the draft classification of samples was revisited and revised and the mapping of types was substantially revised. A number of new types were identified and added, whilst others were combined or split. The verification effectively increased the number of control points from 330 (original samples) by 987 to give a new total of 1,317 verified points to guide the final mapping.

4.6 Capacity Building

An additional objective for the survey was to build local capacity through involving and working with personnel of the National Herbarium, Harare and the ZPWMA, in particular through providing an opportunity for participation in the field work. From the National Herbarium, Anthony Mapaura has been a key member of the team throughout the field sampling and during subsequent analyses, particularly in terms of plant identifications, data entry and computer based analyses of the resulting data bank. His colleague Christopher Chapano has assisted with the identification of specimens in the National Herbarium. Julius Shimbane of FZS comprised a key member of the sampling team and participated throughout the field work. Four university students, currently doing internships within the GNP, joined us for part of the verification work, namely Tendai Chinho, Cheryl Tinashe Mabika, Ruvimbo Nyabawa and B. Tedi, together with Oras Moyo from the park staff.

5. VEGETATION TYPES

The 330 samples were classified into 9 main groups (Types 1 - 9) comprising 27 vegetation types and 10 subtypes. Four additional types with limited distributions were recognized (Types 10 and 11), to give a total of 41 types and sub-types (Table 1). Apart from subtypes 4.1.1 and 4.8.1 which were not sampled, all other units were represented by one or more samples up to a maximum of 38 samples for Type 1.2. Two samples were not classified on the basis that they appeared to represent a mixture between two different types (Stands 12 and 112). Summary data showing the occurrence of woody species by types is shown in Appendix 5, and the occurrence by types of environmental parameters (landscape, geology, soil, slope, aspect, density and size of termitaria), structural properties (height of upper tree layer, height of second tree layer, total woody cover, total tree cover, total shrub cover, total herbaceous cover, litter cover and cover of bare ground) and disturbance factors (surface capping, sheet erosion, gully erosion, fire, grazing/browsing, destruction of trees and overall status of vegetation) in Appendix 6.

There was direct correspondence between the 41 vegetation types/subtypes and map units (Table 2). Three additional units were mapped, comprising river beds, small dams and areas with cultivation (map units 12 – 14) to give a total of 44 map units. The number of polygons and total area for each unit are shown in Table 2. The overall distribution of vegetation types is shown in Map 9, and in more detail for subsections in Maps 10 to 13. Many of the smaller polygons do not display adequately at this small scale. The final map is produced separately at a scale of 1:100,000.

Table 1. List of vegetation types and classification of field samples.

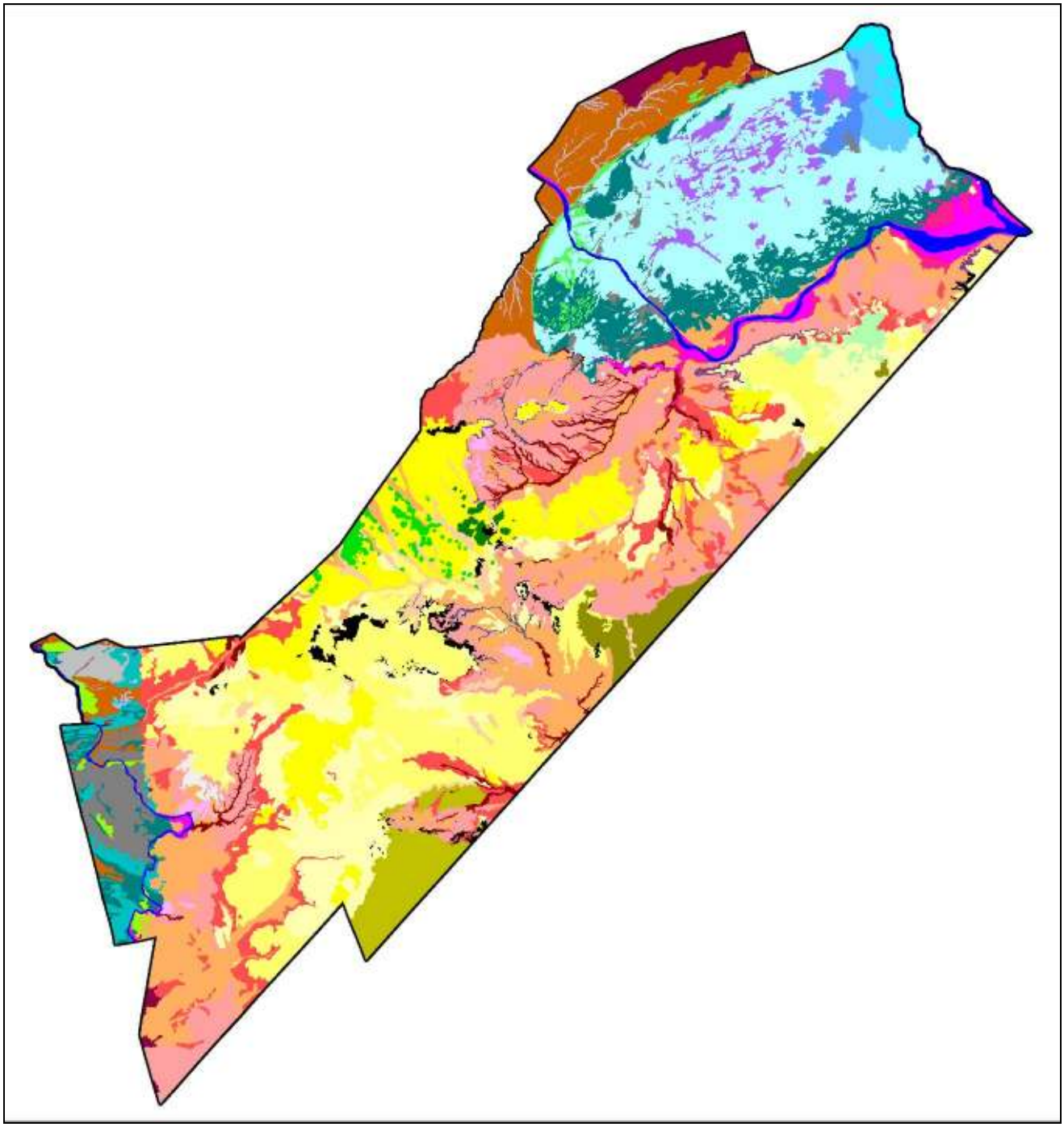
Type	Description	No of Samples	Sample Numbers
1	***Guibourtia conjugata* woodland on Malvernia sands**		
1.1	*Guibourtia conjugata* woodland	13	44, 47, 78, 89, 132, 165, 227, 234, 245, 277, 280, 299, 310
1.1.1	*Guibourtia conjugata* woodland with *Baphia massaiensis*	3	80, 103, 104
1.1.2	*Guibourtia conjugata* woodland with *Millettia usaramensis*	3	91, 179, 239
1.2	Mixed Combretaceae woodland often with *Guibourtia conjugata*	38	30, 31, 41, 42, 49, 50, 57, 67, 70, 79, 90, 101, 107, 108, 109, 110, 113, 114, 115, 116, 120, 121, 123, 131, 133, 162, 167, 168, 172, 180, 222, 226, 231, 240, 271, 312, 314, 315
1.3	Mixed Combretaceae woodland often with *Burkea africana*	31	29, 52, 69, 81, 82, 88, 95, 96, 97, 102, 117, 122, 125, 126, 127, 129, 135, 146, 152, 158, 170, 230, 232, 233, 235, 237, 244, 252, 254, 270, 319
2	**Miombo woodland on Malvernia sands**		
2.1	*Brachystegia-Julbernardia* woodland	9	171, 173, 175, 272, 273, 274, 278, 279, 289
2.2	*Julbernardia globiflora* woodland	4	98, 100, 124, 225
2.3	*Brachystegia tamarindoides* woodland	7	92, 93, 128, 134, 137, 241, 321
3	***Spirostachys africana* woodland in depressions on Malvernia sands and igneous rocks**		
3.1	*Spirostachys africana* woodland on Malvernia sands	8	94, 118, 119, 136, 157, 174, 316, 320
3.1.1	*Spirostachys africana* woodland on igneous rocks	1	215
4	***Colophospermum mopane* woodland on igneous rocks, Malvernia Beds and alluvium**		
4.1	Mopane woodland on basalt and other igneous rocks on heavy clay soils	9	13, 33, 138, 142, 202, 209, 220, 224, 250
4.1.1	Mopane mixed woodland along drainage lines through heavy clay soils	0	
4.2	Mopane woodland on northern igneous rocks on clay loam soils	8	2, 6, 185, 200, 204, 257, 261, 292
4.3	Mopane woodland on southern igneous rocks on clay loam soils	5	19, 23, 25, 27, 66
4.4	Mopane woodland with *Pseudolachnostylis maprouneifolia* on southern igneous rocks on loam soils	7	20, 21, 34, 58, 216, 218, 223
4.5	Mopane woodland on Malvernia heavier textured loam to clay soils	13	5, 11, 46, 99, 111, 149, 159, 160, 169, 228, 256, 275, 288
4.6	Mopane woodland on Malvernia pebbly loam soils	25	32, 38, 55, 56, 61, 62, 74, 75, 85, 130, 144, 145, 147, 150, 161, 176, 177, 178, 229, 236, 246, 291, 313, 317, 325
4.6.1	Mopane mixed woodland on Malvernia steep hills and escarpments	11	151, 153, 154, 251, 253, 255, 265, 281, 286, 300, 327
4.7	Mopane woodland on Malvernia sands	22	26, 39, 43, 48, 51, 53, 63, 72, 73, 77, 106, 164, 166, 242, 243, 258, 259, 290, 304, 318, 323, 324
4.8	Mopane - *Spirostachys africana* woodland along drainage lines	6	28, 40, 45, 54, 68, 181
4.8.1	*Androstachys johnsonii* woodland along Malvernia drainage lines	0	
4.9	Mopane woodland on alluvium	4	163, 183, 305, 309

Type	Description	No of Samples	Sample Numbers
5	**Mixed woodland on northern igneous rocks**		
5.1	Mixed *Brachystegia tamarindoides* woodland	22	3, 10, 16, 17, 187, 188, 190, 195, 197, 198, 199, 203, 205, 207, 211, 263, 296, 301, 308, 326, 328, 330
5.1.1	*Millettia usaramensis* shrubland	2	294, 306
5.2	*Brachystegia tamarindoides* woodland on granite	3	191, 192, 329
5.3	Mixed Combretaceae woodland on granite	2	193, 194
6	**Mixed woodland on northern igneous rocks on heavier soils**		
6.1	Mixed woodland on clay soils	5	9, 18, 206, 293, 307
6.1.1	*Acacia nigrescens* woodland on colluvial soils	1	196
7	***Combretum apiculatum* woodland on igneous rocks**		
7.1	*Combretum apiculatum* woodland on northern igneous rocks	9	1, 14, 139, 140, 141, 143, 189, 208, 264
7.2	*Combretum apiculatum* woodland on southern igneous rocks	5	36, 65, 84, 214, 217
8	***Androstachys johnsonii* woodland on igneous rocks and Malvernia Beds**		
8.1	*Androstachys johnsonii* woodland on northern igneous rocks	7	8, 15, 184, 201, 210, 262, 267
8.2	*Androstachys johnsonii* woodland on southern igneous rocks	6	22, 24, 37, 86, 87, 213
8.2.1	*Androstachys johnsonii* woodland on syenite	2	35, 219
8.3	*Androstachys johnsonii* woodland on Malvernia sands	5	105, 238, 276, 311, 322
8.4	*Androstachys johnsonii* woodland on Malvernia escarpments	3	71, 148, 260
8.4.1	*Androstachys johnsonii* woodland on Malvernia loam soils	1	76
9	**Woodland on alluvium**		
9.1	Mixed woodland on alluvium	24	4, 7, 64, 83, 155, 156, 182, 186, 212, 247, 248, 249, 266, 269, 282, 283, 284, 285, 287, 295, 297, 298, 302, 303
10	**Special communities on southern igneous rocks**		
10.1	Mixed *Galpinia transvaalica* woodland on south facing rhyolite slopes	1	59
10.2	Mixed *Lannea schweinfurthii* woodland on north facing rhyolite slopes	1	60
11	**Special communities on Malvernia Beds**		
11.1	*Strychnos potatorum* woodland on Malvernia sands	1	268
11.2	*Terminalia prunioides* woodland on calcrete	1	221
12	**River beds**	**0**	
13	**Dams**	**0**	
14	**Cultivation**	**0**	
	Not placed	2	12, 112
	Total samples	**330**	

Table 2. Number of polygons, total area and proportion of each type.

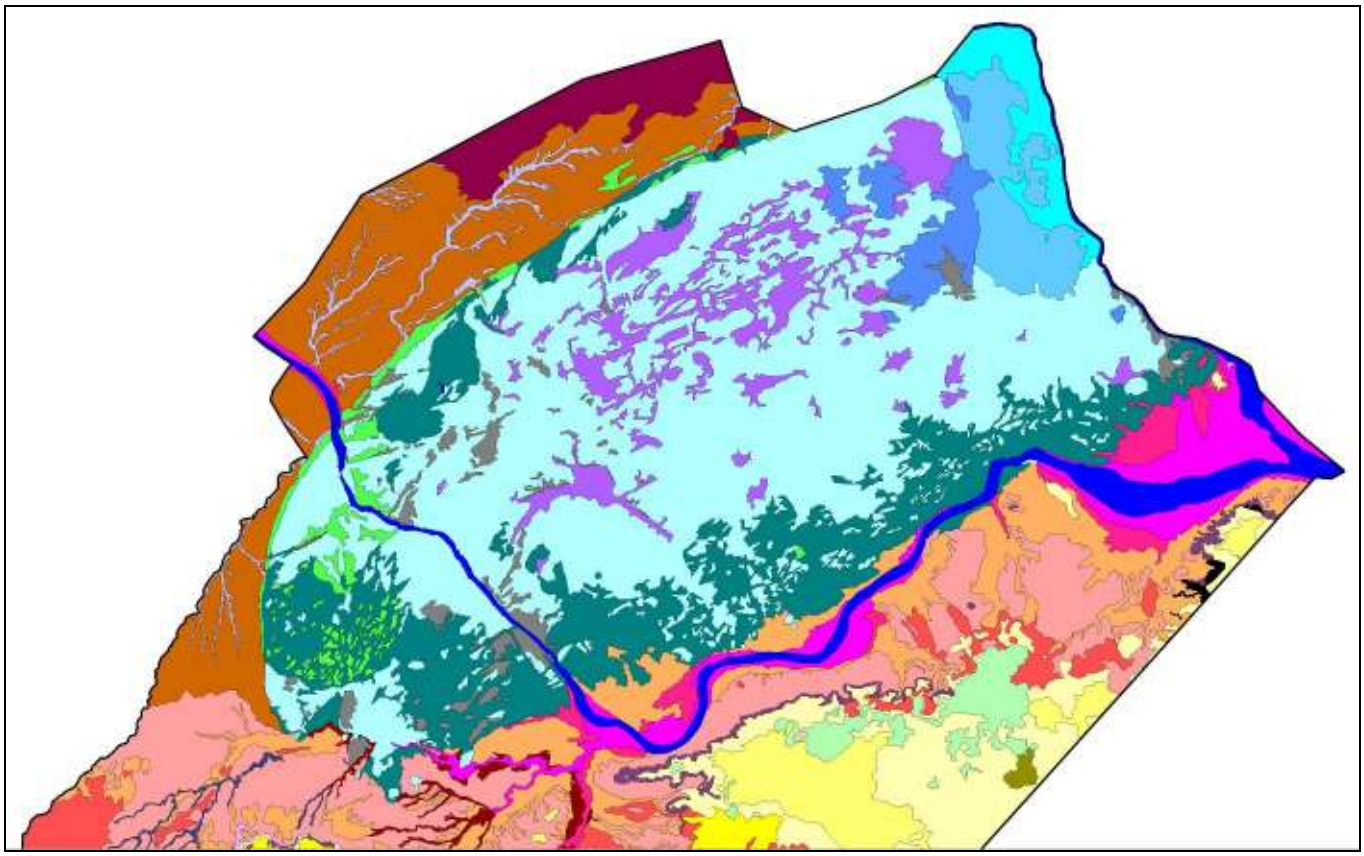
Type	Description	No of Polygons	Area (km^2)	% total area
1.1	*Guibourtia conjugata* woodland	89	536.05	10.4
1.1.1	*Guibourtia conjugata* woodland with *Baphia massaiensis*	4	108.38	2.1
1.1.2	*Guibourtia conjugata* woodland with *Millettia usaramensis*	4	61.64	1.2
1.2	Mixed Combretaceae woodland often with *Guibourtia conjugata*	36	557.67	10.8
1.3	Mixed Combretaceae woodland often with *Burkea africana*	30	423.18	8.2
2.1	*Brachystegia-Julbernardia* woodland	10	27.45	0.5
2.2	*Julbernardia globiflora* woodland	42	27.55	0.5
2.3	*Brachystegia tamarindoides* woodland	9	11.22	0.2
3.1	*Spirostachys africana* woodland on Malvernia sands	20	66.79	1.3
3.1.1	*Spirostachys africana* woodland on igneous rocks	6	3.33	0.1
4.1	Mopane woodland on heavy clay soils on basalt and other igneous rocks	37	193.94	3.7
4.1.1	Mopane mixed woodland along drainage lines through heavy clay soils	10	23.29	0.4
4.2	Mopane woodland on northern igneous rocks on clay loam soils	22	230.07	4.4
4.3	Mopane woodland on southern igneous rocks on clay loam soils	29	41.27	0.8
4.4	Mopane woodland with *Pseudolachnostylis maprouneifolia* on southern igneous rocks on loam soils	36	57.93	1.1
4.5	Mopane woodland on Malvernia heavier textured loam to clay soils	85	632.85	12.2
4.6	Mopane woodland on Malvernia lighter textured loam and pebbly soils	113	583.38	11.3
4.6.1	Mopane mixed woodland on Malvernia steep hills and escarpments	19	14.75	0.3
4.7	Mopane woodland on Malvernia sands	125	274.90	5.3
4.8	Mopane - *Spirostachys africana* woodland along drainage lines	30	63.78	1.2
4.8.1	*Androstachys johnsonii* woodland along Malvernia drainage lines	5	8.87	0.2
4.9	Mopane woodland on alluvium	13	28.54	0.6
5.1	Mixed *Brachystegia tamarindoides* woodland	144	572.66	11.1
5.1.1	*Millettia usaramensis* shrubland	6	28.72	0.6
5.2	*Brachystegia tamarindoides* woodland on granite	2	25.70	0.5
5.3	Mixed Combretaceae woodland on granite	1	43.89	0.8
6.1	Mixed woodland on northern igneous rocks on clay soils	41	88.27	1.7
6.1.1	*Acacia nigrescens* woodland on colluvial soils	1	0.02	0.0
7.1	*Combretum apiculatum* woodland on northern igneous rocks	80	28.58	0.6
7.2	*Combretum apiculatum* woodland on southern igneous rocks	14	18.46	0.4
8.1	*Androstachys johnsonii* woodland on northern igneous rocks	67	31.65	0.6
8.2	*Androstachys johnsonii* woodland on southern igneous rocks	15	80.73	1.6
8.2.1	*Androstachys johnsonii* woodland on syenite	2	25.04	0.5
8.3	*Androstachys johnsonii* woodland on Malvernia sands	108	46.32	0.9
8.4	*Androstachys johnsonii* woodland on Malvernia escarpments	24	15.55	0.3
8.4.1	*Androstachys johnsonii* woodland on Malvernia loam soils	9	21.79	0.4
9.1	Mixed woodland on alluvium	22	65.28	1.3
10.1	Mixed *Galpinia transvaalica* woodland on south facing rhyolite slopes	1	0.09	0.0
10.2	Mixed *Lannea schweinfurthii* woodland on north facing rhyolite slopes	1	0.14	0.0
11.1	*Strychnos potatorum* woodland on Malvernia sands	1	0.10	0.0
11.2	*Terminalia prunioides* woodland on calcrete	2	0.16	0.0
12	River beds	2	62.03	1.2
13	Dams	2	0.10	0.0
14	Cultivation	8	47.06	0.9
	TOTAL	**1327**	**5179.15**	**100**

Map 9. Vegetation types of Gonarezhou National Park.



Legend for vegetation types depicted on Map 9.

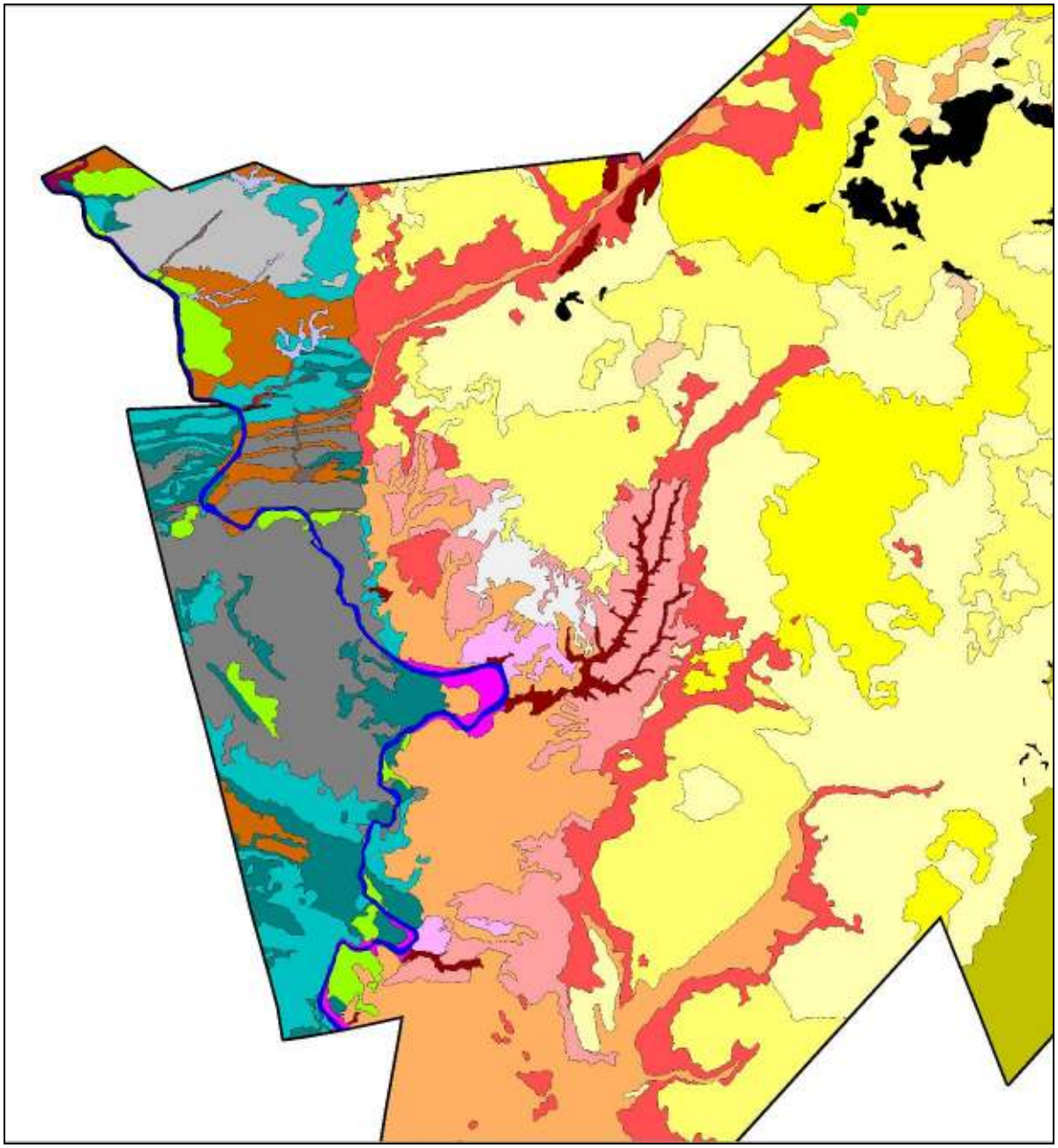
Map 10. Vegetation types of the northern igneous rocks.
(Basalt Types 4.1, 4.1.1; Granophyre Types 3.1.1, 4.2, 5.1, 5.1.1, 6.1, 6.1.1, 7.1, 8.1; Granite Types 5.2 and 5.3, plus Types 12, 13 and 14).



VEGETATION TYPES

- 1.1 Guibourtia conjugata woodland
- 1.1.1 Guibourtia conjugata woodland with Baphia massiensis
- 1.1.2 Guibourtia conjugata woodland with Millettia usaramensis
- 1.2 Mixed Combretaceae woodland often with Guibourtia conjugata
- 1.3 Mixed Combretaceae woodland often with Burkea africana
- 2.1 Brachystegia-Julbernardia woodland
- 2.2 Julbernardia globiflora woodland
- 2.3 Brachystegia tamarindoides woodland
- 3.1 Spirostachys africana woodland on Malvernia sands
- 3.1.1 Spirostachys africana woodland on igneous rocks
- 4.1 Mopane woodland on basalt and other igneous rocks on heavy clay soils
- 4.1.1 Mopane mixed woodland along drainage lines through heavy clay soils
- 4.2 Mopane woodland on northern igneous rocks on clay loam soils
- 4.3 Mopane woodland on southern igneous rocks on clay loam soils
- 4.4 Mopane woodland with Pseudolachnostylis maprouneifolia
- 4.5 Mopane woodland on Malvernia heavier textured loam to clay soils
- 4.6 Mopane woodland on Malvernia pebbly loam soils
- 4.6.1 Mopane mixed woodland on Malvernia steep hills and escarpments
- 4.7 Mopane woodland on Malvernia sands
- 4.8 Mopane - Spirostachys africana woodland along drainage lines
- 4.8.1 Androstachys johnsonii woodland along Malvernia drainge lines
- 4.9 Mopane woodland on alluvium
- 5.1 Mixed Brachystegia tamarindoides woodland
- 5.1.1 Millettia usaramensis shrubland
- 5.2 Brachystegia tamarindoides woodland on granite
- 5.3 Mixed Combretaceae woodland on granite
- 6.1 Mixed woodland on clay soils
- 6.1.1 Acacia nigrescens woodland on colluvial soils
- 7.1 Combretum apiculatum woodland on northern igneous rocks
- 7.2 Combretum apiculatum woodland on southern igneous rocks
- 8.1 Androstachys johnsonii woodland on northern igneous rocks
- 8.2 Androstachys johnsonii woodland on southern igneous rocks
- 8.2.1 Androstachys johnsonii woodland on syenite
- 8.3 Androstachys johnsonii woodland on Malvernia sands
- 8.4 Androstachys johnsonii woodland on Malvernia escarpments
- 8.4.1 Androstachys johnsonii woodland on Malvernia loam soils
- 10.1 Mixed Galpinia transvaalica woodland
- 10.2 Mixed Lannea schweinfurthii woodland
- 11.1 Strychnos potatorum woodland on Malvernia sands
- 11.2 Terminalia prunioides woodland on calcrete
- 12 River bed
- 13 Dam
- 14 Cultivation

Map 11. Vegetation types of the southern igneous rocks.
(Types 3.1.1, 4.1, 4.1.1, 4.3, 4.4, 4.8, 7.2, 8.2, 8.2.1, 10.1, 10.2, plus 12 and 14).

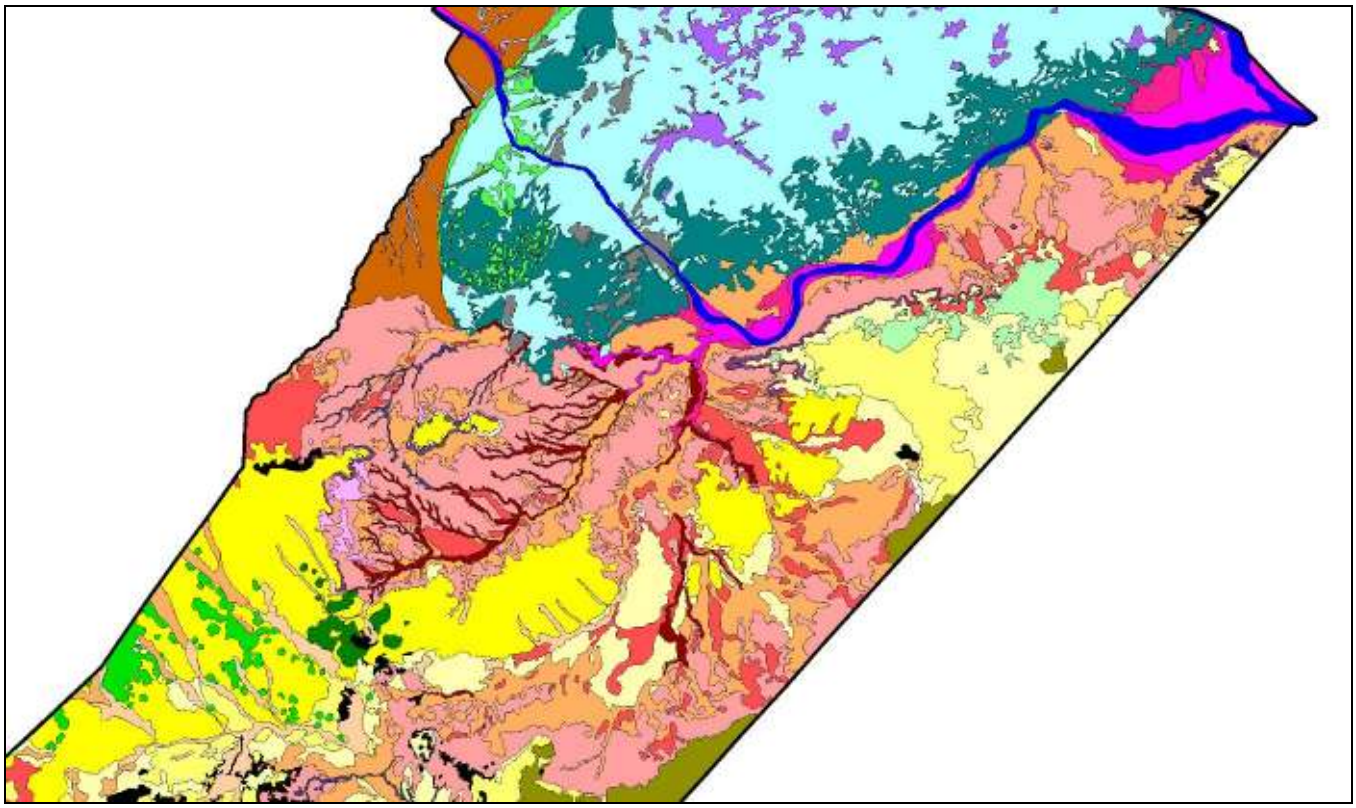


VEGETATION TYPES

- 1.1 Guibourtia conjugata woodland
- 1.1.1 Guibourtia conjugata woodland with Baphia massiensis
- 1.1.2 Guibourtia conjugata woodland with Millettia usaramensis
- 1.2 Mixed Combretaceae woodland often with Guibourtia conjugata
- 1.3 Mixed Combretaceae woodland often with Burkea africana
- 2.1 Brachystegia-Julbernardia woodland
- 2.2 Julbernardia globiflora woodland
- 2.3 Brachystegia tamarindoides woodland
- 3.1 Spirostachys africana woodland on Malvernia sands
- 3.1.1 Spirostachys africana woodland on igneous rocks
- 4.1 Mopane woodland on basalt and other igneous rocks on heavy clay soils
- 4.1.1 Mopane mixed woodland along drainage lines through heavy clay soils
- 4.2 Mopane woodland on northern igneous rocks on clay loam soils
- 4.3 Mopane woodland on southern igneous rocks on clay loam soils
- 4.4 Mopane woodland with Pseudolachnostylis maprouneifolia
- 4.5 Mopane woodland on Malvernia heavier textured loam to clay soils
- 4.6 Mopane woodland on Malvernia pebbly loam soils
- 4.6.1 Mopane mixed woodland on Malvernia steep hills and escarpments
- 4.7 Mopane woodland on Malvernia sands
- 4.8 Mopane - Spirostachys africana woodland along drainage lines
- 4.8.1 Androstachys johnsonii woodland along Malvernia drainge lines
- 4.9 Mopane woodland on alluvium
- 5.1 Mixed Brachystegia tamarindoides woodland
- 5.1.1 Millettia usaramensis shrubland
- 5.2 Brachystegia tamarindoides woodland on granite
- 5.3 Mixed Combretaceae woodland on granite
- 6.1 Mixed woodland on clay soils
- 6.1.1 Acacia nigrescens woodland on colluvial soils
- 7.1 Combretum apiculatum woodland on northern igneous rocks
- 7.2 Combretum apiculatum woodland on southern igneous rocks
- 8.1 Androstachys johnsonii woodland on northern igneous rocks
- 8.2 Androstachys johnsonii woodland on southern igneous rocks
- 8.2.1 Androstachys johnsonii woodland on syenite
- 8.3 Androstachys johnsonii woodland on Malvernia sands
- 8.4 Androstachys johnsonii woodland on Malvernia escarpments
- 8.4.1 Androstachys johnsonii woodland on Malvernia loam soils
- 10.1 Mixed Galpinia transvaalica woodland
- 10.2 Mixed Lannea schweinfurthii woodland
- 11.1 Strychnos potatorum woodland on Malvernia sands
- 11.2 Terminalia prunioides woodland on calcrete
- 12 River bed
- 13 Dam
- 14 Cultivation

Map 12. Vegetation types of the northern Malvernia Beds.

(*Guibourtia conjugata* Types 1.1, 1.1.2, 1.2, 1.3; Miombo Type 2.1; *Spirostachys africana* Type 3.1, Mopane Types 4.5, 4.6, 4.6.1, 4.7, 4.8, 4.8.1, 4.9; *Androstachys johnsonii* Types 8.3, 8.4, 8.4.1; Special Type 11.1, plus Alluvial Type 9.1 and Type 12).



VEGETATION TYPES

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- 1.1.1 Guibourtia conjugata woodland with Baphia massiensis
- 1.1.2 Guibourtia conjugata woodland with Millettia usaramensis
- 1.2 Mixed Combretaceae woodland often with Guibourtia conjugata
- 1.3 Mixed Combretaceae woodland often with Burkea africana
- 2.1 Brachystegia-Julbernardia woodland
- 2.2 Julbernardia globiflora woodland
- 2.3 Brachystegia tamarindoides woodland
- 3.1 Spirostachys africana woodland on Malvernia sands
- 3.1.1 Spirostachys africana woodland on igneous rocks
- 4.1 Mopane woodland on basalt and other igneous rocks on heavy clay soils
- 4.1.1 Mopane mixed woodland along drainage lines through heavy clay soils
- 4.2 Mopane woodland on northern igneous rocks on clay loam soils
- 4.3 Mopane woodland on southern igneous rocks on clay loam soils
- 4.4 Mopane woodland with Pseudolachnostylis maprouneifolia
- 4.5 Mopane woodland on Malvernia heavier textured loam to clay soils
- 4.6 Mopane woodland on Malvernia pebbly loam soils
- 4.6.1 Mopane mixed woodland on Malvernia steep hills and escarpments
- 4.7 Mopane woodland on Malvernia sands
- 4.8 Mopane - Spirostachys africana woodland along drainage lines
- 4.8.1 Androstachys johnsonii woodland along Malvernia drainge lines
- 4.9 Mopane woodland on alluvium
- 5.1 Mixed Brachystegia tamarindoides woodland
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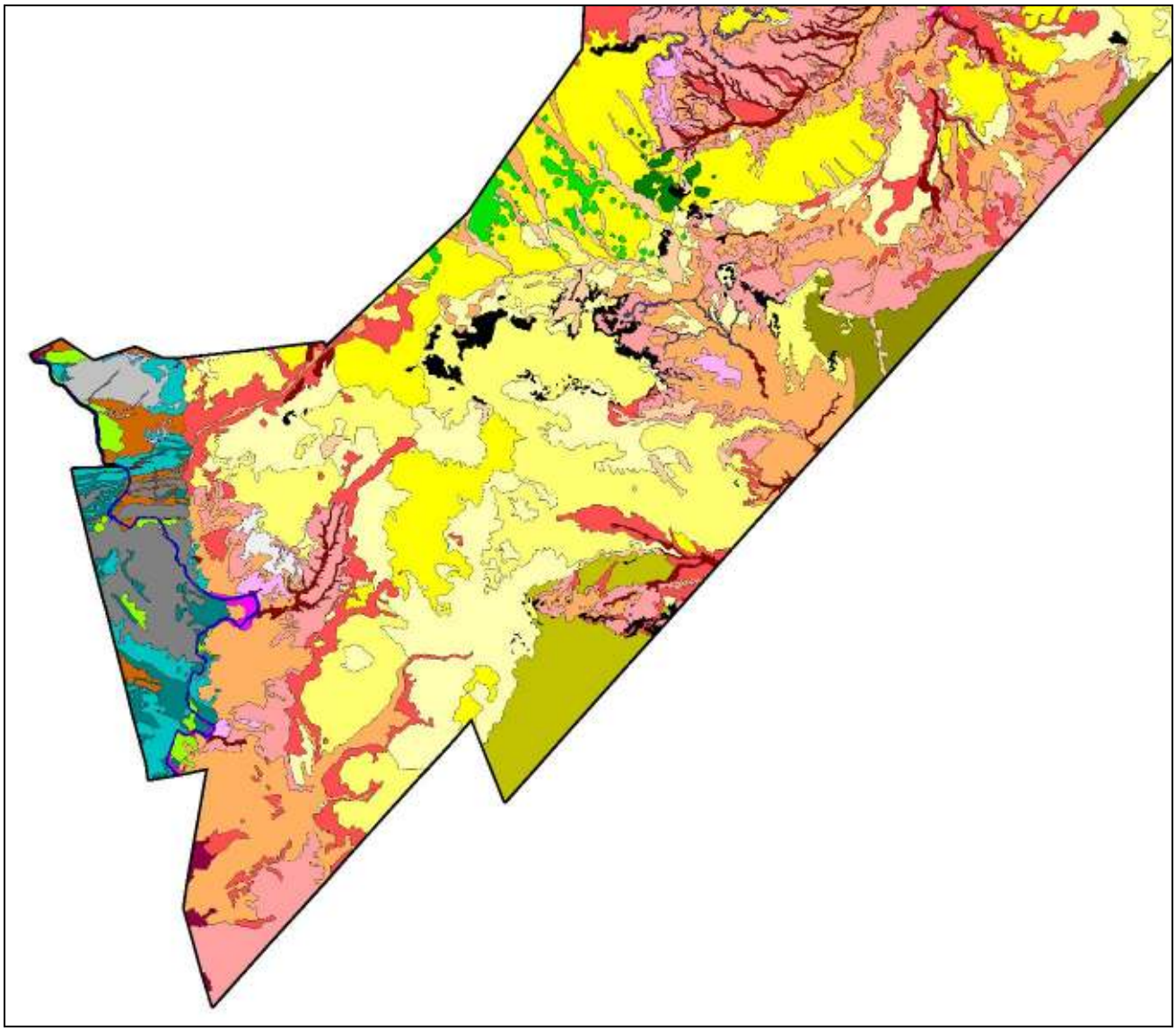
- 7.2 Combretum apiculatum woodland on southern igneous rocks
- 8.1 Androstachys johnsonii woodland on northern igneous rocks
- 8.2 Androstachys johnsonii woodland on southern igneous rocks
- 8.2.1 Androstachys johnsonii woodland on syenite
- 8.3 Androstachys johnsonii woodland on Malvernia sands
- 8.4 Androstachys johnsonii woodland on Malvernia escarpments
- 8.4.1 Androstachys johnsonii woodland on Malvernia loam soils
- 10.1 Mixed Galpinia transvaalica woodland
- 10.2 Mixed Lannea schweinfurthii woodland
- 11.1 Strychnos potatorum woodland on Malvernia sands
- 11.2 Terminalia prunioides woodland on calcrete
- 12 River bed
- 13 Dam
- 14 Cultivation

Map 13. Vegetation types of the southern Malvernia Beds.

(*Guibourtia conjugata* Types 1.1, 1.1.1, 1.1.2, 1.2, 1.3; Miombo Types 2.2 and 2.3; *Spirostachys africana* Type 3.1, Mopane Types 4.5, 4.6, 4.7, 4.8, 4.8.1; *Androstachys johnsonii* Types 8.3, 8.4, 8.4.1; special Type 11.2, plus Alluvium Type 9.1 and Types 12 and 14).



VEGETATION TYPES

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- 1.1.2 Guibourtia conjugata woodland with Millettia usaramensis
- 1.2 Mixed Combretaceae woodland often with Guibourtia conjugata
- 1.3 Mixed Combretaceae woodland often with Burkea africana
- 2.1 Brachystegia-Julbernardia woodland
- 2.2 Julbernardia globiflora woodland
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- 4.1 Mopane woodland on basalt and other igneous rocks on heavy clay soils
- 4.1.1 Mopane mixed woodland along drainage lines through heavy clay soils
- 4.2 Mopane woodland on northern igneous rocks on clay loam soils
- 4.3 Mopane woodland on southern igneous rocks on clay loam soils
- 4.4 Mopane woodland with Pseudolachnostylis maprouneifolia
- 4.5 Mopane woodland on Malvernia heavier textured loam to clay soils
- 4.6 Mopane woodland on Malvernia pebbly loam soils
- 4.6.1 Mopane mixed woodland on Malvernia steep hills and escarpments
- 4.7 Mopane woodland on Malvernia sands
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- 5.2 Brachystegia tamarindoides woodland on granite
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- 8.2.1 Androstachys johnsonii woodland on syenite
- 8.3 Androstachys johnsonii woodland on Malvernia sands
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- 8.4.1 Androstachys johnsonii woodland on Malvernia loam soils
- 10.1 Mixed Galpinia transvaalica woodland
- 10.2 Mixed Lannea schweinfurthii woodland
- 11.1 Strychnos potatorum woodland on Malvernia sands
- 11.2 Terminalia prunioides woodland on calcrete
- 12 River bed
- 13 Dam
- 14 Cultivation

5.1 Overview of Vegetation Types

Southern Africa is one of the regions where the underlying geology determines the soil type. Besides climate, the soil is one of the most important environmental factors that influences species distribution and composition. The Malvernia Beds which cover most of the Park occur nowhere else in the country and the vegetation types which they support are unique to Zimbabwe. The intrusive igneous belts which occur in the north and southwest of the Park comprise some unusual rock types, and although they occur elsewhere the microclimate of the GNP is sufficiently different that one would expect some differences in the species composition compared to similar vegetation types outside the park. On alluvial deposits and basalt derived soils the vegetation in the Park was no different from elsewhere in the lowveld on similar soils.

The most widespread of the vegetation types on the Malvernia Beds was a *Guibourtia conjugata* dominated woodland (Type 1.1), that in its original state was probably more like a dry forest with a shrubby understorey similar in structure to the dry forests which occur on Kalahari sand in the west of Zimbabwe. In many parts, where elephant damage and subsequent fires had created open spaces over large areas, secondary woodland had become established (Types 1.2 and 1.3). For both types different species of Combretaceae were the dominant trees, the main ones being *Combretum apiculatum, C. collinum* subsp. *collinum, C. zeyheri, Pteleopsis myrtifolia* and *Terminalia sericea*. Also widespread on the Malvernia Beds were three types of *Colophospermum mopane* woodland occurring on different soil types and each characterized by different arrays of associate species (Types 4.5, 4.6 and 4.7). In addition to the above, there were on the Malvernia Beds three types of miombo woodland (Types 2.1, 2.2 and 2.3) all of which had a more localized distribution and constituted exceedingly rare and most unusual plant communities, practically confined to the park. In depressions and along drainage lines there were occasional small patches of *Spirostachys africana* woodland (Type 3.1) and Mopane – *Spirostachys africana* woodland (Type 4.8), both limited in extent. Apart from this, there were two widely scattered types of *Androstachys johnsonii* woodland, one on sands (Type 8.3) and one on escarpments and on gentler terrain on loam soils (Type 8.4). Also on the Malvernia Beds, two very unusual vegetation types were noted both extremely limited in extent and both close to the ecotone between the Malvernia Beds and adjacent igneous rocks. One was found to the south of Massasanya Dam and was dominated by *Strychnos potatorum* (Type 11.1) the other was in the southwest of the Park and dominated by *Terminalia prunioides* (Type 11.2).

On the granophyre plateau in the north, on light textured soils over large areas on flat ground and hill sides, there was a mixed woodland originally dominated by *Brachystegia tamarindoides* subsp. *torrei* and now heavily degraded (Type 5.1). On granite a similar type of *Brachystegia tamarindoides* woodland (Type 5.2) and a Combretaceae dominated secondary woodland type (Type 5.3) were identified. Lower on the catena on heavier soils there was a mixed woodland in which besides several *Combretum* species*, Philenoptera violacea, Spirostachys africana* and occasionally *Crossopteryx febrifuga* were prominent (Type 6.1). Along the southern rim of the plateau there was a belt of *Colophospermum mopane* woodland, mainly on syenite derived soils (Type 4.2). Apart from this, there was on the plateau *Androstachys johnsonii* woodland on rocky hill tops (Type 8.1) and *Combretum apiculatum* woodland on some of the slopes (Type 7.1). The basalt plains in the north of the Park were covered with *Colophospermum mopane* woodland (Type 4.1) and *Combretum apiculatum* woodland (Type 7.1) occurred on some of the basalt slopes up towards the granophyre plateau.

The vegetation on the igneous complex in the southwest of the Park consisted mainly of types of *Combretum apiculatum* (Type 7.2) and *Androstachys johnsonii* woodland (Type 8.2), together with three types of *Colophospermum mopane* woodland occurring on heavy clay soils derived from basalt (Type 4.1) and loam soils derived from various rock types (Types 4.3 and 4.4). Two unusual vegetation types occurred on steep sided slopes on rhyolite hills. One was confined to cooler south facing slopes where the most common woody plant was the exceedingly rare *Galpinia transvaalica* (collected only once before in Zimbabwe on the Mateke Hills) (Type 10.1). The other, on warmer

north facing slopes, had a very different species composition dominated by *Lannea schweinfurthii* var. *stuhlmannii* and *Gardenia resiniflua* subsp. *resiniflua* (Type 10.2).

Riparian vegetation occurred wherever there were alluvial deposits (Type 9.1). The most extensive patches occurred in the Save/Runde River junction area and in the vicinity of Fishan's Kraal. In places alluvium supported patches of mopane woodland (Type 4.9).

5.2 Descriptions of Vegetation Types

Type 1. *Guibourtia conjugata* Woodland on Malvernia Sands

Over much of the Malvernia Beds the soils consisted of sands. The woodlands which covered the sands had over the last forty or so years been severely damaged by elephants. This opening up of the woody vegetation had over time caused an enormous increase in the volume of grass, so leading to new patterns of veld fires and as a consequence even more woodland destruction. The newly opened up areas had created space for secondary woodland types to become established. What was observed during the fieldwork were vegetation patterns which must have been drastically different from the original vegetation types, and which were the result of a totally new set of species selection pressures. One was confronted with patterns of vegetation which did not necessarily relate to the underlying environmental variables, and which were in many areas still superimposed on rudiments of the original vegetation. All this made classification and mapping of vegetation extremely difficult.

Over extensive areas the original *Guibourtia conjugata* was clearly the dominant species and there was little invasion by secondary woodland species. It was therefore classified as *Guibourtia conjugata* woodland (Type 1.1). In certain areas within the *Guibourtia conjugata* woodland two subtypes were recognized, both with high woody cover in the subcanopy or shrub layers which presented a distinctive signature on the satellite imagery. In one *Baphia massaiensis* subsp. *obovata* var. *obovata* was prominent in the shrub layer and occasionally present in the subcanopy (Subtype 1.1.1), in the other *Millettia usaramensis* subsp. *australis* was prominent in the subcanopy and fairly common in the shrub layer (Subtype 1.1.2). Apart from this the two subtypes were similar to *Guibourtia conjugata* woodland.

Elsewhere two types of generally highly degraded secondary woodland could be recognized. For one of them (Type 1.2) it could be assumed that the original vegetation was *Guibourtia conjugata* woodland, since it contained many of its typical associate species and *Guibourtia conjugata* was often still prominent. In the other (Type 1.3) most of the characteristic associate species of *Guibourtia conjugata* woodland were scarce or absent and *Guibourtia conjugata* was less prominent. There were also several commonly recorded species which were never noted in Type 1.1 and which were of much lower frequency in Type 1.2. Generally the frequencies of occurrence of the shared species were in Type 1.2 intermediate between Type 1.1 and 1.3. However, surprisingly a few species were significantly more common in Type 1.2 than they were in either Type 1.1 or 1.3. It was not clear what the original vegetation of Type 1.3 could have been, whether it was a type of *Guibourtia conjugata* woodland or one in which *Burkea africana* was prominent.

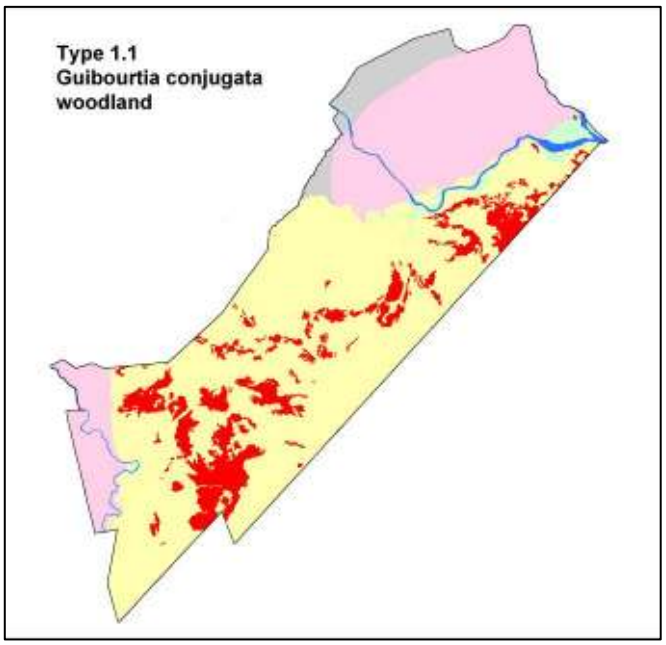
The following woodland types were identified:

Type 1.1 *Guibourtia conjugata* woodland
  Subtype 1.1.1 *Guibourtia conjugata* woodland with *Baphia massaiensis*
  Subtype 1.1.2 *Guibourtia conjugata* woodland with *Millettia usaramensis*
Type 1.2 Mixed Combretaceae woodland often with *Guibourtia conjugata*
Type 1.3 Mixed Combretaceae woodland often with *Burkea africana*

Type 1.1. *Guibourtia conjugata* Woodland

13 Stands: 44, 47, 78, 89, 132, 165, 227, 234, 245, 277, 280, 299, 310.

This woodland type occurred in numerous units of various sizes and covered large areas of the Malvernia Beds from just west of the Mwenezi River in the south to the vicinity of the Save-Runde junction to the northeast of the park. The total extent was approximately 536 km^2. Thirteen stands were investigated.



The topography consisted of level upland sand plains in five of the stands, very gentle to gentle undulating slopes in seven stands, and a bottom flat plain in one stand. The underlying geology was Malvernia Beds. The soils were sands in half of the stands, loamy sands in the other half, and sandy loam in one. No outcropping or loose surface rock was observed. Large termitaria were recorded in three of the stands, medium ones also in three, and small ones in one, all of them at a density of 1 to 5 per ha. In five stands none were noted and in one stand the termitaria were not assessed.

The most common tree species in the top canopy was *Guibourtia conjugata*. *Colophospermum mopane* was recorded in four of the stands. Occasionally or rarely recorded typical canopy species were *Acacia nigrescens*, *A. welwitschii* subsp. *delagoensis, Adansonia digitata*, *Balanites maughamii*, *Entandrophragma caudatum*, *Lannea schweinfurthii* var. *stuhlmannii*, *Newtonia hildebrandtii*, *Spirostachys africana, Strychnos potatorum* and *Xeroderris stuhlmannii*. *Guibourtia conjugata* had a cover of approximately 30% in two stands and 25% in one.

In the second tree layer *Guibourtia conjugata* was also the dominant tree species. Common and widespread associate species were *Cassia abbreviata* subsp. *beareana, Combretum apiculatum, C. collinum* subsp. *collinum* and *Xeroderris stuhlmannii*. Less widespread but still fairly common trees were *Boscia albitrunca*, *Markhamia zanzibarica, Philenoptera bussei*, *Pteleopsis myrtifolia*, *Pterocarpus lucens* subsp. a*ntunesii, Strychnos decussata, S. madagascariensis*, *S. potatorum* and *S. spinosa*. Occasionally or rarely occurring but typical tree species were *Acacia burkei*, *A. nigrescens*, *Albizia forbesii*, *Brachylaena huillensis*, *Lannea schweinfurthii* var. *stuhlmannii*, *Ozoroa paniculosa* var. *paniculosa* and *Spirostachys africana*. The liana *Hugonia orientalis* was a common species in the second tree layer, occasionally forming large clumps. *Guibourtia conjugata* had a cover of approximately 55% in one stand, 26 to 40% in three, 12 to 20% in four and 10% in three stands. *Combretum apiculatum* and *C. collinum* subsp. *collinum* had a cover of 5 to 10% in two stands each.

Hugonia orientalis was the most common species in the shrub layer. Other common shrubs were *Coptosperma zygoon, Monodora junodii* var. *junodii* and *Tricalysia allenii*. Less widespread but typical shrub species were *Combretum mossambicense*, *C. celastroides* subsp. *celastroides*, *Erythrococca menyharthii*, *Hymenocardia ulmoides*, *Maerua parvifolia*, *Phyllanthus pinnatus*, *Senna petersiana*, *Uvaria gracilipes* and *Vangueria infausta* subsp. *infausta*. *Baphia massaiensis* subsp. *obovata* var. *obovata*, *Combretum celastroides* subsp. *celastroides* and *Millettia usaramensis* subsp. *australis* were locally very common. *Androstachys johnsonii,* normally found on hills and in gullies, was of sporadic occurrence throughout the *Guibourtia* woodland, forming small clumps or larger patches, often reaching up into the second tree layer and typically interspersed with standing dead trees. The tree species *Combretum apiculatum*, *C. collinum* subsp. *collinum*, *Guibourtia conjugata*,

Pteleopsis myrtifolia, *Strychnos madagascariensis* and *Xeroderris stuhlmannii* could all be prominent or even locally dominant in the shrub layer. *Guibourtia conjugata* had a cover of 3 to 8% in three stands, *Combretum celastroides* subsp. *celastroides* had a cover of about 60% in one stand and 10% in another, and *Monodora junodii* var. *junodii* had a cover of 2% in one stand.

In many stands the herbaceous groundcover was mainly made up of grass species. In most areas the dominant grass species was *Digitaria milanjiana*. Frequently dominant or co-dominant grass species were *Aristida meridionalis*, *A. mollissima, A. rhiniochloa*, *Perotis patens* and *Pogonarthria squarrosa*. Locally dominant grasses were *Eragrostis aspera*, *E. lehmanniana*, *E. pallens, Sacciolepis curvata* and *Schmidtia pappophoroides*. Species of forbs recorded were *Hemizygia bracteosa*, *Indigofera praticola*, *Sphenostylis erecta*, *Vernonia poskeana* and *Waltheria indica,* which occurred frequently. In some areas the groundcover was devoid of grasses, with much bare ground and a loose cover of *Hemizygia bracteosa*.

Tree height in the top canopy was between 15 to 18 m in four stands, up to 20 m in nine stands. Canopy cover was 1% or less in eight stands, 2 to 5% in four, and 20% in one. In most stands the trees were widely and irregularly scattered, in a few places there were occasional clumps of trees left, and in one there were still a fair number of large trees, not forming a canopy but fairly evenly distributed (Stand 132).

In the second tree layer the heights of the trees were 4 to 12 m, rarely up to 15 m. Canopy cover was estimated at 10 to 25% in seven, 30 to 35% in three, and 40 to 60% also in three. In most of the stands the bulk of the woodland was in the second tree layer, often rather clumped but occasionally more evenly distributed. In many areas most of the second layer consisted of mutilated mature specimens, mainly of *Guibourtia conjugata*. In some stands young multi-stemmed specimens of *Combretum collinum* subsp. *collinum* and to a lesser extent *C. apiculatum* were also prominent.

The cover of the shrub layer varied considerably from very low in some stands to unusually high in others. It was 1 to 2% in three stands, 3 to 7% in seven, and 17%, 35% and 70% in one each. The high cover value in one stand (Stand 132) was due to the presence of dense stands of *Androstachys johnsonii* and *Combretum celastroides* subsp. *celastroides*.

The total woody cover was 15 to 30% in six stands, 35 to 50% in four, 50 to 60% in two, and 90 to 100% in one stand (Stand 132).

The herbaceous groundcover was sparse and patchy underneath trees and much denser and more even in the open areas. In stands with a low tree cover (<20%) the grass cover was even throughout. In many stands there were patches of *Guibourtia conjugata* seedlings in the vicinity of large trees.

It is assumed that in its original state the structure of this vegetation type would be a dry forest, with the tree canopies touching and a shrub layer underneath. In one or two stands, where the second tree layer was fairly even, the impression of a degraded dry forest was still conveyed. A few other stands had small fragments which resembled dry forest. Otherwise the structure was open woodland or open shrubland and in the most degraded stands wooded grassland.

In some stands, especially the better wooded ones, there was much evidence of recent elephant damage in the form of mutilated trees and standing and fallen dead trees. In other stands recent damage was moderate. However, accumulated long term damage by elephant and fire was severe everywhere, bordering on almost total devastation in the worst hit areas. Top canopy trees were scarce or absent over large areas. In some parts the tree cover was still from 25 to 60%, but mainly in the second layer, and almost all the trees were multi-trunked, often from the base. There was always a pattern of open spaces where almost all woody vegetation had been removed. In the better wooded areas the spaces were between 50 to 200 m^2, in the most degraded ones they could be up to one hectare or more. Where fires had been recent the shrubby vegetation was burned down to ground

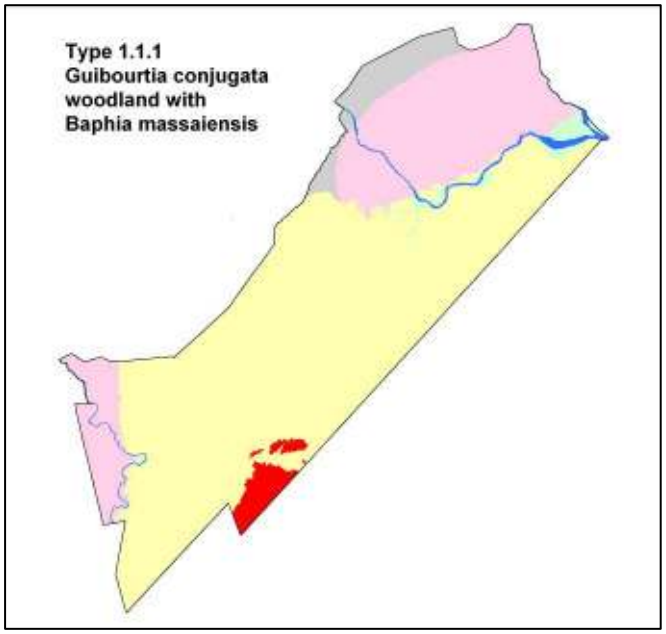
level. The further back the time of the last fire the larger the regrowth. There was much evidence of the development of secondary woodland, mainly by tree species belonging to the family of the Combretaceae. The most common invading species were *Combretum collinum* subsp. *collinum*, *C. apiculatum*, *Pteleopsis myrtifolia* and *Terminalia sericea*. Almost all of them were multi-stemmed from having been burned down to ground level, probably repeatedly.

Subtype 1.1.1. *Guibourtia conjugata* Woodland with *Baphia massaiensis*

3 Stands: 80, 103, 104.

This vegetation subtype was found within the *Guibourtia conjugata* woodland but only along the Mozambique border stretching east of the railway line for some 25 km to the northeast of Sango. The total extent was approximately108 km^2. Three stands were investigated.

The topography consisted of level upland sand plains and the soils varied from sands to loamy sands. In one stand there were large termitaria at a density of 1 to 5 per ha, in another medium ones at a density of more than 5 per ha, and the third one had none.



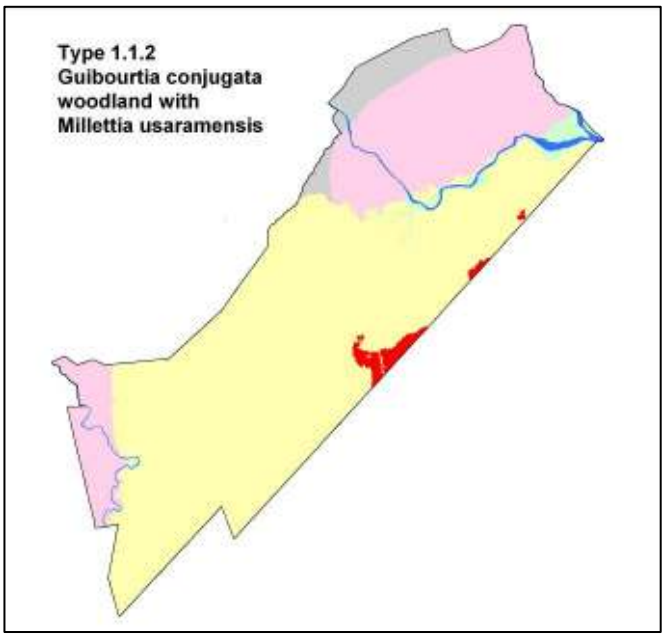
This subtype was similar in species composition to *Guibourtia conjugata* woodland except that *Baphia massaiensis* subsp. *obovata* var. *obovata* was a prominent component of the shrub layer and occasionally present in the lower tree layer, which caused it to show up clearly on the satellite imagery. The cover of *Baphia massaiensis* subsp. *obovata* var. *obovata* was up to 25% in one stand, up to 10% in another and approximately 3% in the third. In the remainder of the *Guibourtia conjugata* woodland *Baphia massaiensis* subsp. *obovata* var. *obovata* was either scarce or mostly absent. All three stands investigated contained besides *Guibourtia conjugata*, *Hugonia orientalis*, *Monodora junodii* var. *junodii, Pteleopsis myrtifolia* and *Strychnos madagascariensis*, all of which were common in *Guibourtia conjugata* woodland. They also shared *Balanites maughamii* which was only recorded in three out of thirteen stands in *Guibourtia conjugata* woodland.

In one stand (Stand 80 – near Sango) *Millettia stuhlmannii* was fairly prominent, with a cover of about 1% in the subcanopy and 2% in the shrub layer. This was the only stand out of the nineteen stands of *Guibourtia conjugata* woodland investigated where *Millettia stuhlmannii* was recorded. *Pteleopsis myrtifolia* and *Strychnos madagascariensis* both had a cover of about 3% in the shrub layer of the same stand, and *Combretum celastroides* subsp. *celastroides* one of 10% in the shrub layer of another one.

Subtype 1.1.2. *Guibourtia conjugata* Woodland with *Millettia usaramensis*

3 Stands: 91, 179, 239.

This vegetation subtype was also found along the southern boundary within the *Guibourtia conjugata* woodland, in the headwaters of the Nyamasikana catchment area. Its total extent was about 62 km^2. Three stands were investigated.

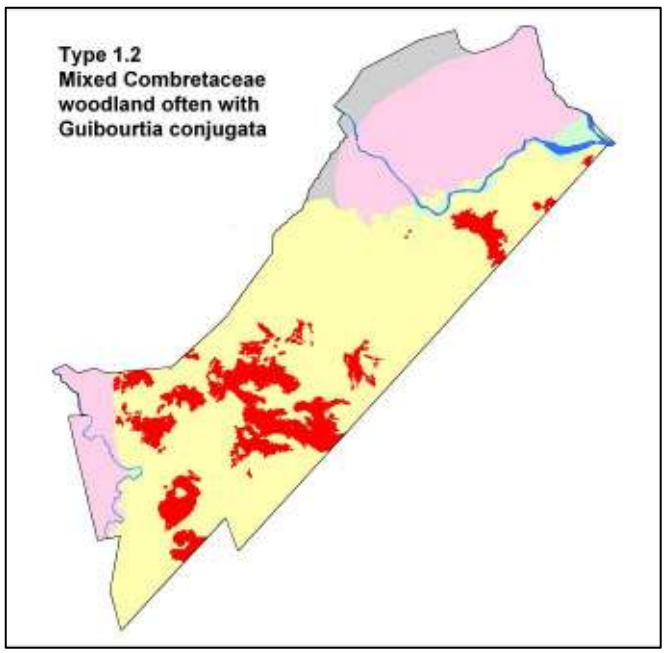


The topography consisted of flat to gently undulating upland plains in two stands and an incipient slope in the third. There was no surface rock and the soils were sand in one stand and loamy sands in two. There were large termitaria in two stands and small ones in the other, all at a density of 1 to 5 per ha.

This subtype was similar to *Guibourtia conjugata* woodland in species composition except that *Millettia usaramensis* subsp. *australis* was prominent in the subcanopy, which gave it a distinct signature on the satellite imagery. The cover of *Millettia usaramensis* subsp. *australis* in the subcanopy was up to 10% in one stand, 30 to 50% in another, and up to 70% in the third. On the Malvernia Beds *Millettia usaramensis* subsp. *australis* was essentially confined to the vicinity where this subtype occurred. Of the species commonly found in *Guibourtia conjugata* woodland, the three stands investigated, in addition to *Guibourtia conjugata* shared *Hugonia orientalis*, *Monodora junodii* var. *junodii, Philenoptera bussei*, *Pterocarpus lucens* subsp. *antunesii* and *Tricalysia allenii.* They also shared *Markhamia zanzibarica* and *Phyllanthus pinnatus* which occurred in about half of the *Guibourtia conjugata* woodland stands, and *Acacia ataxacantha*, *Strophanthus kombe* and *Xylia torreana*, which only occurred in two to four of the thirteen *Guibourtia conjugata* woodland stands. In one of the three stands (Stand 91) *Baphia massaiensis* subsp. *obovata* var. *obovata* had a cover of up to 10% in the subcanopy, more or less equal to that of *Millettia usaramensis* subsp. *australis.* The bulk of the *Millettia usaramensis* subsp. *australis*, because of its height of mainly over 3 m, was recorded in the subcanopy, however it appeared as a tall shrub layer beneath the *Guibourtia* trees. In one stand where the best preserved canopy of mature *Guibourtia conjugata* was noted (Stand 179), estimated at between 35 to 40%, an indication was given of how this woodland looked previously. *Guibourtia conjugata* had a cover of 10% and 40% in the subcanopy of one stand each. *Guibourtia conjugata, Monodora junodii* var. *junodii* and *Phyllanthus pinnatus* had a cover of 2 to 3% in the shrub layer of the same stand.

Type 1.2. Mixed Combretaceae Woodland often with *Guibourtia conjugata*

38 Stands: 30, 31, 41, 42, 49, 50, 57, 67, 70, 79, 90,101, 107, 108, 109, 110, 113, 114, 115, 116, 120, 121, 123, 131, 133, 162, 167, 168, 172, 180, 222, 226, 231, 240, 271, 312, 314, 315.



This vegetation type, like Type 1.1, occurred across most of the Malvernia Beds. It was essentially a secondary woodland type in which up to five species of Combretaceae could occur, of which two or more could often be co-dominant. The total area covered was approximately 558 km^2. Thirty eight stands were investigated.

The topography (upland plains and gentle slopes), geology (Malvernia Beds) and soils (loamy sands and sands) were similar to *Guibourtia conjugata* woodland. The termitaria recorded were large in twenty-five stands and medium sized in two, all except one at a density

of 1 to 5 per hectare. In one there were slightly more than 5 large termitaria per hectare. In nine stands no termitaria were noted and for one stand no assessment was made.

The most frequently recorded top canopy tree was *Guibourtia conjugata,* occurring in half of the stands investigated. Fairly common canopy species were *Spirostachys africana* and *Xeroderris stuhlmannii,* occasionally noted ones were *Acacia nigrescens, Colophospermum mopane, Combretum collinum* subsp. *collinum, Sclerocarya birrea* subsp. *caffra* and *Strychnos madagascariensis*. Rarely noted, but never the less typical, canopy species were *Afzelia quanzensis, Balanites maughamii, Berchemia discolor, Lannea schweinfurthii* var. *stuhlmannii* and *Philenoptera bussei.* In six stands there were no canopy trees left.

In the second tree layer the most common species was *Combretum collinum* subsp. *collinum*. It was dominant or co-dominant in twenty four out of thirty eight stands. Once it had a cover score of 35 to 45%, in six stands the cover was 15 to 20% and in seventeen stands it was between 5 and 8%. Other common and widespread tree species were *Combretum apiculatum, Guibourtia conjugata, Pteleopsis myrtifolia, Strychnos madagascariensis, Terminalia sericea* and *Xeroderris stuhlmannii*. *Combretum apiculatum* was dominant in seven stands and co-dominant in twelve. In six stands its cover was 15 to 20% and in twelve stands it was 4 to 8%. *Guibourtia conjugata* was dominant in five stands and co-dominant in eight. In two stands it had a cover of 12 to 20% and in eleven stands its cover was 5 to 8%. *Pteleopsis myrtifolia* had a cover of up to 8% in seven stands and was the co-dominant species in five. *Terminalia sericea* was dominant in one stand and co-dominant in two, and had a cover of between 5 and 8% in these three stands. *Strychnos madagascariensis* was co-dominant with *Guibourtia conjugata* in one stand. Slightly less common tree species in the sub canopy, occurring in 50 to 70% of the stands, were *Cassia abbreviata* subsp. *beareana, Combretum zeyheri, Dalbergia nitidula, Diplorhynchus condylocarpon, Lannea schweinfurthii* var. *stuhlmannii, Pseudolachnostylis maprouneifolia* and *Strychnos spinosa.* Of these *Combretum zeyheri* was three times co-dominant with a cover of about 8%, and once dominant with an approximate cover of 20%. Most of the *Guibourtia conjugata* specimens in this layer were knocked down and mutilated mature specimens showing regrowth.

All of the above mentioned tree species contributed substantially to the shrub layer, especially the Combretaceae species, so did *Hugonia orientalis* (a liana) which occurred in 80% of the stands. Shrubby species were relatively scarce. *Senna petersiana* was the most common one occurring in 70% of the stands. *Cissus cornifolia, Dalbergia nitidula* (a small tree that was usually in the shrub layer), *Ozoroa paniculosa* var. *paniculosa* (a small tree but often only a shrub in the study area), *Tricalysia allenii* and *Vangueria infausta* subsp. *infausta* were all recorded in 42 to 50% of the stands. *Dichrostachys cinerea* subsp. *africana* and *Erythrococca menyharthii* were also typical shrubs, but with more limited frequencies (29% of the stands). *Combretum apiculatum* and *Dalbergia nitidula* had a cover of 2% in the shrub layer of two stands each. *Diplorhynchus condylocarpon* and *Strychnos madagascariensis* had a cover of 2 to 5% in two stands each. *Hugonia orientalis* had a cover of 3%, *Guibourtia conjugata* one of 2% and *Markhamia zanzibarica* one of 5%, all in one stand each.

This type could be distinguished from Type 1.1 by the much higher cover of any one or several of the five Combretaceae species which commonly occur on the Malvernia sands, namely *Combretum apiculatum, C. collinum* subsp. *collinum, C. zeyheri, Pteleopsis myrtifolia* and *Terminalia sericea*, and also by the presence of *Diplorhynchus condylocarpon* and *Pseudolachnostylis maprouneifolia,* both of which were recorded in about half the stands but never in Type 1.1. It could be distinguished from Type 1.3 by the presence of typical associate species of *Guibourtia conjugata* woodland, for example *Pterocarpus lucens* subsp. *antunesii, Monodora junodii* var. *junodii, Combretum mossambicense* and *Hymenocardia ulmoides*. All of these were present in ten to fourteen stands out of thirty-eight, but absent or only present in one stand out of thirty-one in Type 1.3. The dominance of the five Combretaceae was similar in both Types 1.2 and 1.3, except that *Combretum apiculatum* was more common and widespread in Type 1.2 and *C. zeyheri* in Type 1.3.

Apart from this none of the other common woody species could be used to distinguish this type from either Type 1.1 or 1.3. However a few species were significantly more common in this type than in either of the other two. They were *Lannea schweinfurthii* var. *stuhlmannii* which was recorded in twenty-four (63%) of the stands, whereas it was recorded in three (23%) in Type 1.1 and five (16%) in Type 1.3; *Dalbergia nitidula* which occurred in eighteen (47%) of the stands, compared to once (8%) in Type 1.1 and four stands (13%) in Type 1.3; *Boscia foetida* subsp. *rehmanniana* was found in twelve (32%) of the stands and was noted in two (13%) in Type 1.1 and once (3%) in Type 1.3, and *Grewia bicolor* was recorded in ten (26%) stands but never in Type 1.1 and only once (3%) in Type 1.3. *Cissus cornifolia, Coffea racemosa, Combretum apiculatum, Erythrococca menyharthii* and *Xeroderris stuhlmannii* were also more common in this type but to a lesser extent. Of these *Coffea racemosa* and *Erythrococca menyharthii* were recorded only once in Type 1.3. The relative high abundance of the above mentioned nine species compared with Types 1.1 and 1.3 is surprising since none of them except *Combretum apiculatum* are obvious invading species. It is also somewhat incongruous with the assumption that this type has derived from Type 1.1.

The herbaceous ground cover was mainly made up of grass species, quite dense in some places whilst in others the individual grass tufts were clearly visible. In a few areas forbs were noticeable in among the grasses. The most often dominant grass species were *Digitaria milanjiana* and *Pogonarthria squarrosa.* Frequently dominant or co-dominant grasses were *Aristida mollissima, A. rhiniochloa* and *Eragrostis pallens.* Occasionally dominant grasses were *Aristida congesta, A. meridionalis, A. stipitata, Eragrostis lehmanniana, Panicum maximum, Perotis patens, Schmidtia pappophoroides* and *Urochloa mosambicensis*. The most frequently recorded forb was *Waltheria indica,* other conspicuous forbs were *Centemopsis kirkii, Dicerocaryum senecioides, Hemizygia bracteosa, Triumfetta pentandra* and *Zornia glochidiata*.

Height of the trees in the top canopy was 15 to 20 m, and in four stands up to 25 m. Canopy cover was 1% or less in twenty-three stands, 2 to 5% in three, and in twelve stands there were no mature canopy trees left.

Tree height in the second canopy was 4 to 12 m. Canopy cover was 5 to 15% in thirteen stands, 16 to 30% in nineteen, and 35 to 50% in six.

Superficially this woodland type looked similar to Type 1.3. Trees were either clumped or more evenly distributed especially in the better wooded parts. In some areas the development of secondary woodland was well advanced with fairly even stands of up to 10 m tall trees. In other areas the woodland looked like a 5 to 6 m tall shrub layer, in places even merging with the actual shrub layer at 3 m.

The cover of the shrub layer was generally low, 1 to 3% in thirteen stands, 4 to 6% in nineteen, 7 to 10% in five, and 20% in one. The shrubs were irregularly scattered or less often clumped.

Total woody cover was 10 to 25% in sixteen stands, 26 to 40% also in sixteen, and 41 to 50% in six stands.

The cover of the herbaceous layer varied considerably, it was 10 to 30% in sixteen stands, 31 to 50% in twelve, 51 to 60% in five, and 61 to 80% also in five.

As in all the secondary woodland types on sand, the structure varied in accordance with degradation from wooded grassland to open shrubland or open woodland.

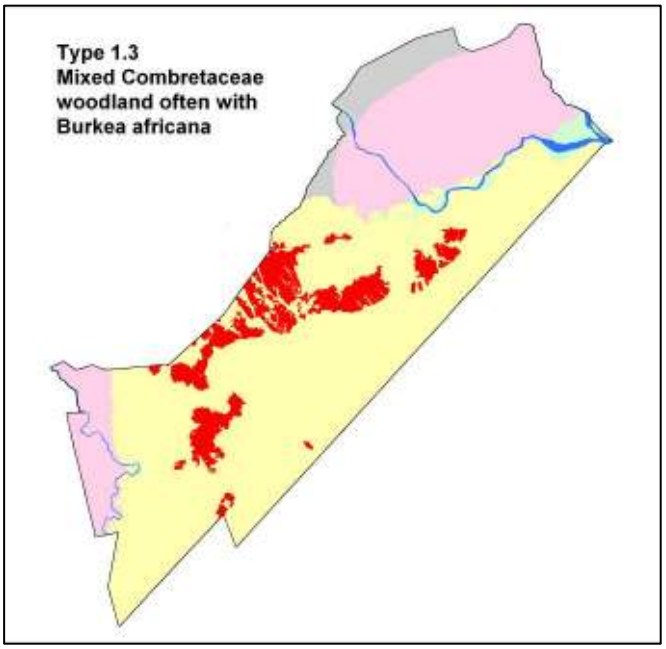
In many stands recent elephant damage was noted, there were standing and fallen dead trees and quite a number of damaged, or damaged and subsequently regenerating, trees and shrubs. In some areas mature *Guibourtia conjugata* trees had been reduced to the level of the shrub layer. The woodland was in the process of being opened up by fire and elephants. Fire damage was observed up to the

second tree layer. In the better wooded places there was a fairly regular pattern of open spaces of up to about 100 m^2 in size. The spaces increased with increased degradation, in the most affected areas they were one hectare or more in extent. Development and destruction of secondary woodland occurred simultaneously in different places.

Type 1.3. Mixed Combretaceae woodland often with *Burkea africana*

31 Stands: 29, 52, 69, 81, 82, 88, 95, 96, 97, 102, 117, 122, 125, 126, 127, 129, 135, 146, 152, 158, 170, 230, 232, 233, 235, 237, 244, 252, 254, 270, 319.

This vegetation type was found within the central portion of the Malvernia Beds over a 75 km belt of land, starting from a point situated about 10 km west of the railway line and extending east to just short of the Chilojo Cliffs. This was clearly a secondary vegetation type. What it was derived from must remain uncertain, since the existing vegetation did not provide enough evidence to make any definite conclusions as to what constituted the primary woodland. It occurred in numerous units of varied sizes and its approximate extent was 423 km^2. Thirty-one stands were investigated.



The topography consisted in twenty stands of a level upland plain, five stands were on a ridge top and six on a gentle to gently undulating slope. The underlying geology was Malvernia Beds and the soils were sands in four stands, loamy sands in twenty-one, sandy loam in four, loam in one and loamy clay also in one. There were large termitaria in four stands, medium ones also in four and small ones in one stand, all at a density of 1 to 5 per ha. In nineteen stands no termitaria were recorded and for three stands no assessment was made.

Mature top canopy trees were relatively scarce. Occasionally recorded species were *Pseudolachnostylis maprouneifolia* and *Sclerocarya birrea* subsp. *caffra* (both in six out of thirty-one stands); *Burkea africana, Spirostachys africana* and *Xeroderris stuhlmannii* (all in five stands), and *Erythrophleum africanum, Guibourtia conjugata* and *Pterocarpus angolensis* in three stands each.

In the second tree layer *Combretum collinum* subsp. *collinum* and *Terminalia sericea* were the dominant tree species. *Combretum collinum* subsp. *collinum* had a cover of up to 8% in eleven stands, 20% in nine and 35% in one. *Terminalia sericea* had a cover of up to 8% in ten stands. *Diplorhynchus condylocarpon* and *Pteleopsis myrtifolia* were equally widespread but slightly less frequent. The latter had a cover of up to 8% in three stands, 30% in one and was totally dominant with a cover of about 45% also in one (Stand 135). *Diplorhynchus condylocarpon* had a cover of approximately 20% in the subcanopy of one stand. Also widespread, occurring in 28 or 29 out of the 31 stands, but not quite as common as the above, were *Ochna pulchra* subsp. *pulchra, Pseudolachnostylis maprouneifolia, Strychnos madagascariensis* and *Xeroderris stuhlmannii*. All of these except *Xeroderris stuhlmannii* had a cover of 5 to 8% in one stand. *Burkea africana, Combretum apiculatum, C. zeyheri, Guibourtia conjugata, Sclerocarya birrea* subsp. *caffra* and *Strychnos madagascariensis* were less widespread, occurring in 16 to 21 stands, but could be locally common. *Combretum apiculatum* had a cover of 5 to 8% in three stands and 20% in one; *C. zeyheri* had a cover of 8% in two stands, 20% in one and 35% also in one; and *Guibourtia conjugata* had a cover of up to 8% in three stands.

The shrub layer consisted mainly of young trees. The dominant ones were *Combretum collinum* subsp. *collinum, Diplorhynchus condylocarpon, Ochna pulchra* subsp. *pulchra, Strychnos madagascariensis* and *Terminalia sericea*. All occurred throughout and had a cover of 2 to 8% in four to six stands, and *Combretum collinum* subsp. *collinum* had a cover of about 30% in one stand. Slightly less frequent but also widespread species were *Pseudolachnostylis maprouneifolia* and *Pteleopsis myrtifolia.* Less widespread but occasionally common tree species in the shrub layer were *Burkea africana, Combretum apiculatum, C. zeyheri, Guibourtia conjugata, Ozoroa paniculosa* var. *paniculosa, Sclerocarya birrea* subsp. *caffra, Strychnos spinosa* and *Xeroderris stuhlmannii.* Fairly common shrub species were *Euclea natalensis* subsp. *angustifolia* and *Senna petersiana.* Other typical but not always present shrub species were *Catunaregam swynnertonii, Cissus cornifolia, Dichrostachys cinerea* subsp. *africana, Uvaria gracilipes* and *Vangueria infausta* subsp. *infausta*. Of the above, *Euclea natalensis* subsp. *angustifolia* had a cover of 3 to 4% in two stands, *Combretum apiculatum, C. zeyheri* and *Xeroderris stuhlmannii* one of about 3% in one stand each, *Pteleopsis myrtifolia* one of 2% and *Uvaria gracilipes* 4% also in one stand each.

In most stands the herbaceous ground cover consisted mainly of grass species with forbs only occasionally prominent. The most often dominant grass species were *Pogonarthria squarrosa* and *Schmidtia pappophoroides*. Occasionally dominant species were *Aristida mollissima, Digitaria milanjiana* and *Eragrostis pallens.* Rarely dominant species were *Aristida congesta, A. meridionalis, Eragrostis lehmanniana, Heteropogon contortus, Panicum maximum* and *Urochloa mosambicensis.* Forbs recorded were *Blepharis diversispina, Corchorus trilocularis, Harpagophytum zeyheri* subsp. *sublobatum, Hibiscus micranthus* and *Waltheria indica.*

Tree height in the top canopy ranged from 15 to 20 m with emergent trees up to 28 m. There were no top canopy trees in seventeen stands, in twelve there was a canopy cover of less than 1%, and in two stands the cover was 2 to 4%.

Tree height in the second layer was 4 to 10 m. Canopy cover in the second tree layer was very variable. There was no second layer to speak of in one stand. In four stands the cover was 1 to 5%, in nineteen 6 to 20%, in three 20 to 30%, in one 40%, and in three 50%.

The shrub layer was generally quite sparse. Its cover was 1 to 5% in nine stands, 6 to 20% in twenty one, and 25 to 30% in one.

Total woody cover was 5% in one stand, 5 to 15% in six, 16 to 35% in fifteen, 35 to 50% in six, and 50 to 60% in three.

The ground cover was 20 to 40% in twelve stands, 40 to 50% in eleven, 50 to 60 % in seven, and 80 to 100% in one.

The vegetation structure was wooded grassland in half of the stands and, depending on the height of the vegetation, either open shrubland or open woodland in the other half.

The shared dominance of one or several Combretaceae species between this type and Type 1.2, as well as an overlap in the general species composition, make it difficult to distinguish them from each other. This is a good example of convergence of vegetation types due to degradation. Typical woody species for this vegetation type were *Burkea africana, Catunaregam swynnertonii, Dalbergia melanoxylon, Diplorhynchus condylocarpon, Euclea natalensis* subsp. *angustifolia*, *Ochna pulchra* subsp. *pulchra,* and *Pseudolachnostylis maprouneifolia*. If some of them occurred together one could be certain to be in this vegetation type. All of these species were also noted in Type 1.2. However, as compared with Type 1.2, *Burkea africana* was about seven times more common in this vegetation type, *Euclea natalensis* subsp. *angustifolia* and *Ochna pulchra* subsp. *pulchra* three times, and the five other species mentioned above almost twice. Other less common species that were never or rarely seen in Types 1.1 or 1.2 were *Peltophorum africanum, Philenoptera violacea* and *Pterocarpus angolensis.*

Also some of the typical associate species of *Guibourtia conjugata* woodland that occurred also in Type 1.2 were exceedingly rare or absent in this type. Examples are given under Type 1.2.

This was one of the most degraded vegetation types in the park. There was none or very little of the top canopy left (up to 4% cover in two stands was the highest), and in three stands (Stands 69, 96 and 127) even the second tree layer had almost disappeared. Half of the stands had a total woody cover of less than 25%, the lowest being 5% (Stand 69). Much of the woody vegetation consisted of multi-stemmed or multi-trunked regrowth, mostly from the base, after the trees had been burnt down to ground level.

In the better wooded stands (40 to 60% cover) there was a fairly regular pattern of open spaces, most of them less than 100 m^2 in size. In the badly degraded areas the open spaces could be up to one hectare or even larger.

Many stands were too degraded to show much recent elephant damage. In others there were still numerous standing and fallen dead trees, most of them large mature specimens, and much bark damage was observed on the few large trees still alive.

In some areas within this vegetation type there were fairly numerous dead specimens of large mature *Burkea africana* and *Pterocarpus angolensis*. Among the still living large canopy trees *Burkea africana, Pseudolachnostylis maprouneifolia* and *Sclerocarya birrea* subsp. *caffra* were fairly prominent. This points towards a second primary woodland type on Malvernia sands, besides the *Guibourtia conjugata* woodland types, and the type discussed here would be a degraded form of it. The vegetation analysis by computer, although often unreliable with degraded vegetation, separated this type fairly clearly from all others on Malvernia sands.

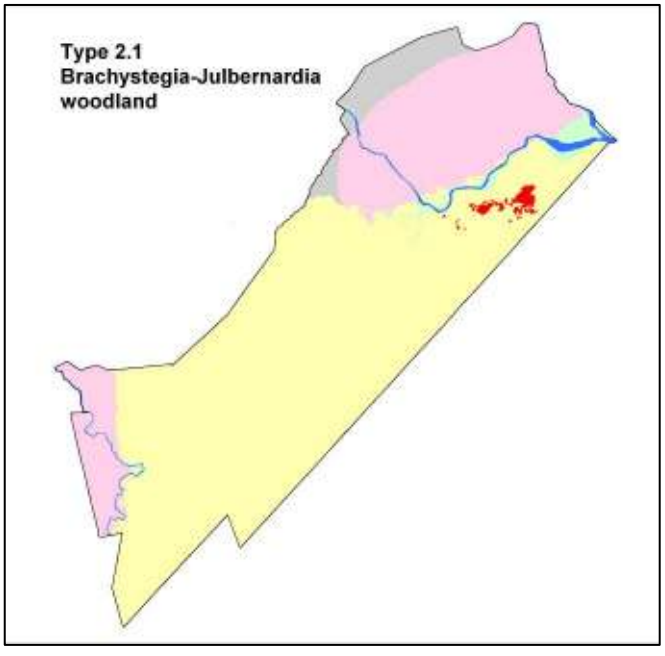
Type 2. Miombo Woodland on Malvernia Sands

Three vegetation types were found on the Malvernia Beds in which miombo species were prominent. One was a mixed woodland in which two *Brachystegia* species and *Julbernardia globiflora* were present (Type 2.1). Of the other two, one was completely dominated by *Julbernardia globiflora* (Type 2.2) and the other by *Brachystegia tamarindoides* subsp. *torrei* (Type 2.3). Both are most unusual plant communities only found in southern lowveld of Zimbabwe.

Type 2.1. *Brachystegia – Julbernardia* Woodland

9 Stands: 171, 173, 175, 272, 273, 274, 278, 279, 289.

This woodland type occurred only in one area to the northeast of the park, in the vicinity of the Chilojo cliffs and extending for some 20 km to the east. It was approximately 27 km^2 in extent and consisted of 10 mapped units of various sizes. Nine sites were investigated. The topography was generally flat or gently undulating, the geology Malvernia Beds and the soil sand or loamy sand. Large termitaria were recorded in three stands and medium sized ones in two, all at a density of 1 to 5 per ha. In four stands no termitaria were seen.



The most common top canopy trees were *Brachystegia spiciformis, B. tamarindoides* subsp. *torrei* and *Julbernardia globiflora*. Less

common but still frequent canopy species were *Guibourtia conjugata* and *Xeroderris stuhlmannii*; occasional but typical associates were *Erythrophleum africanum*, *Lannea schweinfurthii* var. *stuhlmannii*, *Peltophorum africanum*, *Philenoptera bussei* and *Sclerocarya birrea* subsp. *caffra*.

The main species of the second tree layer were, in order of general abundance: *Combretum collinum* subsp. *collinum*, *Xeroderris stuhlmannii*, *Pteleopsis myrtifolia*, *Brachystegia tamarindoides* subsp. *torrei*, *Julbernardia globiflora*, *Strychnos madagascariensis*, *Diplorhynchus condylocarpon*, *Guibourtia conjugata, Pseudolachnostylis maprouneifolia*, *Strychnos spinosa, Cassia abbreviata* subsp. *beareana*, *Sclerocarya birrea* subsp. *caffra*, *Boscia albitrunca*, *Terminalia sericea*, *Combretum zeyheri*, *Philenoptera bussei* and *Brachystegia spiciformis*. The above order of importance is taken over the entire extent of the vegetation type. In specific localities both *Brachystegia* species as well as *Julbernardia globiflora* can be dominant. Other less frequently encountered, but nevertheless typical tree species, were *Boscia foetida* subsp. *rehmanniana*, *Diospyros loureiriana* subsp. *loureiriana*, *Lannea schweinfurthii* var. *stuhlmannii*, *Margaritaria discoidea* subsp. *nitida, Markhamia zanzibarica*, *Ochna pulchra* subsp. *pulchra* and *Vangueria infausta* subsp. *infausta*. The latter three species were sometimes small trees but generally more abundant as shrubs. In one stand (Stand 274) *Millettia stuhlmannii* was recorded, where it was co-dominant with *Brachystegia spiciformis* and *Julbernardia globiflora* and had a cover of up to 5% in the subcanopy. Most trees were mature multitrunked specimens which had regrown after mutilation. In one area 20 dead standing *Millettia stuhlmannii* trees were counted from one point, and some specimens were noted that had burnt down to ground level.

The most widely recorded components of the shrub layer were *Ochna pulchra* subsp. *pulchra*, *Vangueria infausta* subsp. *infausta*, *Senna petersiana*, *Monodora junodii* var. *junodii* (sometime a small tree) and the two lianas *Artabotrys brachypetalus* and *Hugonia orientalis*. Some of the tree species, especially but not only the invading ones, featured prominently as shrubs. The most common ones were *Pteleopsis myrtifolia*, *Strychnos madagascariensis*, *Xeroderris stuhlmannii*, *Combretum collinum* subsp. *collinum*, *Brachystegia tamarindoides* subsp. *torrei*, *B. spiciformis*, *Julbernardia globiflora*, *Diospyros loureiriana* subsp. *loureiriana, Margaritaria discoidea* subsp. *nitida* and *Markhamia zanzibarica*. Other locally prominent species in the shrub layer were *Coffea racemosa, Clerodendrum robustum, Dalbergia nitidula*, *Euclea natalensis* subsp. *angustifolia* (the latter two sometimes as small trees), the two climbers *Ancylobotrys petersiana* and *Synaptolepis alternifolia*, plus *Coptosperma zygoon* and *Ximenia caffra*. Generally, degradation has rendered the shrub layer less species rich than expected. The lack of shrubby Rubiaceae was especially noticeable.

The groundcover consisted mainly of closely spaced individual tufts of grasses intermingled with a noticeable portion of forbs. The dominant grass species were *Pogonarthria squarrosa*, *Digitaria milanjiana* and *Aristida rhiniochloa*. The forbs were mainly *Dicerocaryum senecioides* and *Waltheria indica*.

Mature trees were between 15 to 18 m in height. Canopy cover was estimated at less than 1% in three of the stands, between 1 to 3% in five and at 5% in one. The trees were widely and irregularly scattered, often totally absent over large areas or occasionally clumped. Only in one stand (Stand 279) were the mature trees widely but fairly evenly distributed.

The second tree layer was mainly staggered in height, often no more than 5 to 6 metres tall. In some places regrowth of the original species would reach up to 12 or more metres. Canopy cover was estimated at 2 to 5% in four of the stands, 8 to 12% in three and between 30 to 35% in the remaining two (Stands 278 and 279). The layer consisted partly of relatively young invading secondary species, mainly belonging to the family Combretaceae, and partly of regrowth of the original trees. The regrowth was often up to 10 or more years old. In two of the nine stands, the trees were still fairly evenly distributed, interspersed with relatively small open areas to approximately 200 m^2 in size. For the remainder the trees and shrubs were irregularly clumped or more openly scattered, and separated by variously shaped open areas of mainly grassland up to one hectare or even more in size.

Mature shrubs could be up to 4 m or slightly more in height. Cover abundance was estimated as low as 2% in one stand (Stand 287), but normally between 4 and 10%. The shrubs rarely formed a visible layer. They were often staggered in height and irregularly scattered, in some places as individual specimens in others aggregated either in clumps or loose groups.

Total woody cover varied from as low as 8% up to 50% for the two stands which had a better tree cover.

Ground cover by grass and forbs varied from 15% in the better wooded stands, to 50% in the most degraded ones, but in most places it was between 30 and 40%.

Not all nine stands placed into this type conformed well. Typical for this type was the association of *Brachystegia spiciformis, B. tamarindoides* subsp. *torrei* and *Julbernardia globiflora*. Stands 171 and 273 both contained *Brachystegia tamarindoides* subsp. *torrei* only and in Stand 272 only *Julbernardia globiflora* was present, which meant that they could also be extremely degraded forms of Types 2.2 or 2.3 respectively. However, they were placed here because of their general species composition and their geographical position. Types 2.2 and 2.3 occurred only some 60 to 80 km to the southwest of this type.

One stand (Stand 274) contained *Millettia stuhlmannii* (panga panga) with a cover abundance of up to 10%. This species has a sporadic occurrence and was only recorded a few times during this study, always on the Malvernia deposits and mainly towards the eastern boundary of the Park.

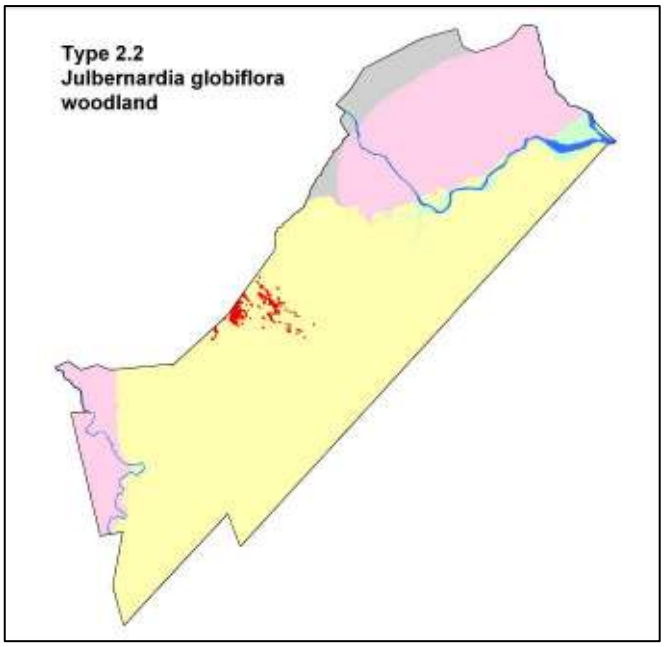
The structure of this vegetation type was, depending on the state of degradation, wooded grassland, open shrubland or open woodland, bordering on to woodland in two stands.

Over most of its distribution this vegetation type was extensively degraded, to the extent that species composition had undergone considerable change and the volume of woody biomass had been drastically reduced. Only moderate recent elephant damage was observed and relatively few dead trees were encountered. The impression gained was that degradation had proceeded over a long period of time and most likely commenced as early as the 1970's.

Type 2.2. *Julbernardia globiflora* Woodland

4 Stands: 98, 100, 124, 225.

This vegetation type was found in the middle section of the Park within the headwaters of the Guluweni drainage, with parts of it extending to the western boundary fence and beyond. It occurred in numerous discrete small patches which showed up as distinct amorphously shaped or rounded units on the satellite imagery. The total area covered was approximately 28 km^2. Four stands were investigated.



The topography was mainly flat, in some area gently undulating. The underlying geology was Malvernia Beds and the soil consisted of loamy sand or sandy loam in various shades of brown. Large termitaria were recorded in three stands at a density of 1 to 5 per ha. In one stand there were none.

Julbernardia globiflora was the only tree species in the top canopy.

The second tree layer consisted of a mixture of regrowth of original trees and young trees. The most common tree species were *Julbernardia globiflora*, *Pteleopsis myrtifolia*, *Xeroderris stuhlmannii*, *Erythrophleum africanum*, *Combretum collinum* subsp. *collinum* and *Margaritaria discoidea* subsp. *nitida.* The latter is a small tree more often found in the shrub layer but in this vegetation type it can be prominent in the second tree layer, in one stand mature specimens attained a cover abundance of up to 10%. Other typical but less common tree species were *Diplorhynchus condylocarpon*, *Lannea schweinfurthii* var. *stuhlmannii* and *Pseudolachnostylis maprouneifolia*.

The most common species in the shrub layer was *Julbernardia globiflora*, reaching a cover abundance of 10% in some places. Other widespread and common species were *Monodora junodii* var. *junodii*, *Senna petersiana*, *Margaritaria discoidea* subsp. *nitida*, *Artabotrys brachypetalus*, *Vangueria infausta* subsp. *infausta* and *Diplorhynchus condylocarpon*. Typical but less widespread species were *Dalbergia nitidula*, *Erythrophleum africanum*, *Euclea natalensis* subsp. *angustifolia* (locally abundant), *Lannea schweinfurthii* var. *stuhlmannii*, *Lagynias dryadum*, *Psydrax livida*, *Pseudolachnostylis maprouneifolia*, *Pteleopsis myrtifolia* and *Xeroderris stuhlmannii*. *Clerodendrum robustum* was a sub-shrub that typically occurred in this vegetation type.

The ground cover consisted mainly of grasses with some forbs in between. Common grass species were *Digitaria eriantha*, *D. milanjiana*, *Heteropogon melanocarpus*, *Pogonarthria squarrosa* and *Schmidtia pappophoroides*. Forbs recorded were *Asparagus suaveolens*, *Melhania forbesii* and *Triumfetta pentandra*.

The height of the top canopy trees was 13 to 16 m and estimated canopy cover was between 50 to 60% in two of the stands, and 20 to 25% in the other two. In the better wooded stands the canopy was still partly intact, and areas in which the tree crowns nearly touched were interspersed with relatively small, fairly regularly spaced open patches from which the trees had been removed. These patches could be up to about 200 m^2 in size. In the more open stands the trees were irregularly spaced, in some parts mainly single and up to 100 m or more apart. In other areas the trees were in widely scattered loose groups or tight bunches, and the open spaces between the trees were up to half a hectare in extent, or occasionally even larger, and contained either mainly grassland or grassland with clumps of shrubs.

The second tree layer was staggered in height from 5 to 13 m. Its sparse cover was estimated at 5 to 6% and its spacing was haphazard. The regenerating original trees, mainly *Julbernardia globiflora*, were multi-stemmed from the base and occasionally reached up to the canopy. Some of these specimens looked 15 or more years old.

The cover abundance for the shrub layer was estimated at 5 to 10% for three of the stands and between 25 to 30% for the fourth. In the stands with a low cover, the shrubs were widely and irregularly scattered, mainly singly, occasionally in small clumps. In the stand where the shrub cover reached 30% the shrubs were mainly in loose groups or tight clumps of up to 40 m^2 in size.

Total woody cover was estimated at between 30 to 60% and total ground cover at 15 to 40%. The two stands with a canopy cover of 50 to 60% showed one of the best tree covers seen during the entire study.

The structure of the vegetation varied from open woodland to woodland depending on the state of degradation.

The impression gained was that this woodland type was in its original state much denser, bordering in its physiognomy on dry forest, similar to the Type 2.3 *Brachystegia tamarindoides* subsp. *torrei* dominated patches of woodland which also occurred in the Park.

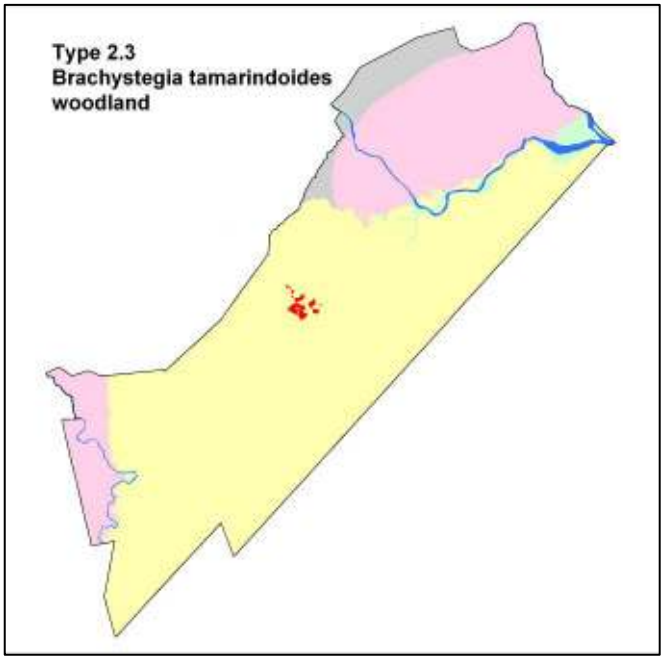
Observed elephant damage was moderate in the already opened up stands. In the better wooded stands there was obvious and frequently encountered evidence of recent tree destruction. In one area seven pushed over trees were observed from one point, and the woodland seemed to be in a period of active tree destruction.

Type 2.3. *Brachystegia tamarindoides* Woodland

7 Stands: 92, 93, 128, 134, 137, 241, 321.

This vegetation type was found in the middle section of the Park along the watershed between the Guluweni and Mutondowari drainages. Like vegetation Type 2.2, it occurred in distinct irregularly shaped or rounded units which were scattered or bunched over a relatively small area. The total area covered was approximately 11 km^2. Seven stands were investigated.

The topography was mainly flat to gently undulating. The geology of the area was Malvernia Beds and the soil was mainly orange brown or more rarely pale to dark brown loamy sand or in one stand sand. In three stands large termitaria were recorded and in one stand medium sized ones, all at a density of 1 to 5 per ha. In two stands there were none and for one stand termitaria were not assessed.



In most areas *Brachystegia tamarindoides* subsp. *torrei* was the sole tree in the top canopy. Other tree species were *Acacia erioloba*, *Albizia forbesii*, *Cleistanthus schlechteri*, *Erythrophleum africanum* and *Guibourtia conjugata*, all of which were exceptional occurrences in the canopy of this vegetation type.

The most widespread and common species in the second tree layer were *Brachystegia tamarindoides* subsp. *torrei* and *Pteleopsis myrtifolia*. *Brachystegia tamarindoides* subsp. *torrei* occasionally had a cover abundance of 10 to 20% and *Pteleopsis myrtifolia* up to 10% in one stand. Other fairly widespread second story tree species were *Boscia albitrunca*, *Combretum collinum* subsp. *collinum*, *C. zeyheri*, *Erythrophleum africanum*, *Guibourtia conjugata*, *Hymenocardia ulmoides*, *Strychnos madagascariensis* and *Suregada zanzibariensis*. The two *Combretum* species can be locally common with a cover of up to 10% in one stand. *Suregada zanzibariensis* was always rare, and the specimens recorded in this association are the only ones known for Zimbabwe.

The shrub layer, although impoverished to what it had previously been, was still species rich compared to other vegetation types in the Park. Common shrub species, in order of importance, were *Senna petersiana, Monodora junodii* var. *junodii, Margaritaria discoidea* subsp. *nitida* (can also be a small tree), *Coptosperma littorale*, *Lagynias dryadum*, *Coffea racemosa*, *Heinsia crinita* subsp. *parviflora*, *Psydrax livida*, *Leptactina delagoensis* subsp. *delagoensis* and *Vepris bremekampii*. Six of these shrub species belong to the family Rubiaceae (coffee family). Tree or liana species which were prominent in the shrub layer included *Artabotrys brachypetalus*, *Brachystegia tamarindoides* subsp. *torrei*, *Combretum collinum* subsp. *collinum*, *Dalbergia nitidula, Diplorhynchus condylocarpon, Erythrophleum africanum*, *Gardenia volkensii* subsp. *volkensii* var. *volkensii, Hugonia orientalis*,

Hymenocardia ulmoides, *Pteleopsis myrtifolia*, *Strychnos madagascariensis*, *Synaptolepis alternifolia, Vitex mombassae* and *Xeroderris stuhlmannii*. Species which reached a cover of up to 10% in some places were *Brachystegia tamarindoides* subsp. *torrei*, *Margaritaria discoidea* subsp. *nitida*, *Monodora junodii* var. *junodii* and *Vepris bremekampii*. The shrubs were widely and irregularly scattered, either singly or in loose groups, occasionally in tighter small clumps. In the stand where the cover was up to 25% the distribution tended to be more regular.

Where there was a tree canopy the ground was mainly bare. In the open areas the herbaceous groundcover was well developed. It consisted mainly of grasses, forbs were noticeably scarce. The dominant grass species were *Aristida rhiniochloa*, *Digitaria milanjiana*, *Pogonarthria squarrosa* and *Schmidtia pappophoroides*.

The trees in the top canopy were between 14 and 20 m in height. Canopy cover varied from less than 1% in two of the stands, to 2%, 5-10% and 15% each in one stand, to 25 to 30% in two.

In the mainly open stands the mature trees were widely and haphazardly scattered and missing over large parts of the land surface. Where the canopy was still partially intact, it occurred in more or less evenly spaced patches or irregular elongated bands with open spaces in between. In some areas the intervening spaces of mainly grassland, or grassland with clumps of shrubs, were rather small in size, up to about 300 m^2, in other areas the open spaces could be up to one ha or even more in extent.

The trees in the second layer were 4 to 8 m high and their cover was mainly up to 5%, except in one stand where the cover was up to 20% and seemed to partly merge with the upper canopy. The trees were irregularly scattered where the cover was low and more evenly distributed in the stand with a higher cover. A good proportion of the trees in this layer were young *Brachystegia tamarindoides* subsp. *torrei*, or those which had been damaged and were regenerating. Invading Combretaceae, mainly *Pteleopsis myrtifolia* and *Combretum collinum* subsp. *collinum,* were common in some stands but scarce in others.

There was no clearly defined layer of shrubs. Their height was staggered from 1 to 4 m and cover was around 10% in all but one stand, in which it was up to 25%. The shrubs were widely and irregularly scattered, either singly or in loose groups, occasionally in tighter small clumps. In the stand where the cover was up to 25% the distribution tended to be more regular.

In the most degraded stand total woody cover was between 8 and 15%. In the three stands which were least degraded it was between 35 and 45%.

There was considerable variation in the herbaceous groundcover. In the severely degraded stands it varied between 40 to 85%. In the stand where there was most canopy cover it was between 5 to 15%.

The structure of the vegetation varied from wooded grassland to open woodland with patches of woodland in the best preserved parts.

Elephant seem to like this habitat. Severe elephant damage was observed even in some of the highly degraded stands, but more so in better wooded areas. Up to eleven standing and up to five fallen trees were noted from one point. Also much damage was noted on living trees, especially debarking of tree trunks and broken off branches.

One stand of this vegetation type was investigated in 1985 by TM. A field sheet was prepared on which it was stated that *Brachystegia tamarindoides* subsp. *torrei* formed a continuous canopy and underneath, at the height of 2 to 3 m, was a distinct green layer consisting of about 20 species of mainly evergreen shrubs. One of the species, *Suregada zanzibariensis*, was listed with a cover abundance value of 10%. Now it is exceedingly rare. Three of the species recorded then were no

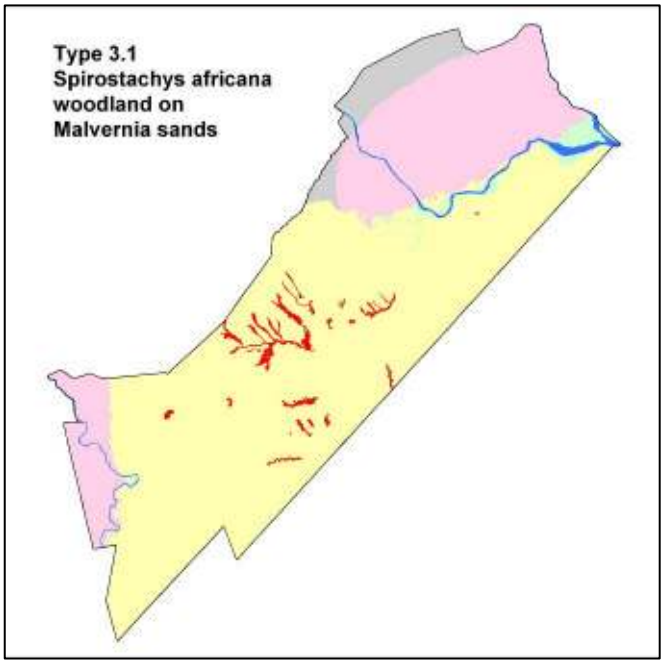
longer found and most of the others were now scarce, and everywhere the continuous top canopy was now fragmented or obliterated.

Type 3. *Spirostachys africana* Woodland in Depressions on Malvernia Sands and Igneous Rocks

Type 3.1 *Spirostachys africana* Woodland on Malvernia Sands

8 Stands: 94, 118, 119, 136, 157, 174, 316, 320.

This vegetation type occurred in the central portion of the Malvernia Beds, from the Chefu to the upper parts of the Nyamasikana drainage, with a single outlier behind the Chilojo cliffs. It occurred as widely scattered and relatively small units related to depressions in the landform, either surrounding a pan or along a gently dipping small drainage line. The total extent of the vegetation type was 67 km^2. Eight stands were investigated.



The topography was an incipiently dipping broad valley or a depression and in one stand it was a slightly undulating plain. All samples occurred on Malvernia Beds. The soils were brownish sandy clay loams or sandy loams in three stands each, brown loam in one and sand also in one. In six stands large termitaria were recorded all at a density of 1 to 5 per ha. In two stands there were none.

The dominant tree species in the top canopy was *Spirostachys africana,* quite frequently it was the only mature canopy species to be seen. It had a cover of up to 25% in three stands and 10% in one. Common associate species which occasionally featured in the canopy were *Berchemia discolor, Colophospermum mopane*, *Combretum imberbe*, *Diospyros mespiliformis*, *Philenoptera violacea* and *Strychnos potatorum*.

The most commonly recorded trees in the second tree layer were, in approximate order of importance, *Spirostachys africana*, *Strychnos madagascariensis*, *Philenoptera violacea*, *Combretum hereroense* var. *hereroense*, *Strychnos potatorum*, *Peltophorum africanum*, *Acacia nilotica* subsp. *kraussiana*, *Colophospermum mopane*, *Berchemia discolor*, *Combretum collinum* subsp. *collinum*, *C. imberbe* and *C. zeyheri.* Typical but less widely distributed tree species were *Acacia nigrescens, Drypetes mossambicensis*, *Lannea schweinfurthii* var. *stuhlmannii*, *Combretum apiculatum*, *Cassia abbreviata* subsp. *beareana*, *Dalbergia melanoxylon, Diospyros mespiliformis* and *Terminalia sericea*. In one stand *Spirostachys africana* had a cover abundance of up to 8%, and in two stands between 15 and 20%, and *Terminalia sericea* had a cover of up to 8% in one stand.

The shrub layer was varied and some tree species contributed substantially towards it. Common species were *Flueggea virosa* subsp. *virosa*, *Dichrostachys cinerea* subsp. *africana*, *Combretum hereroense* var. *hereroense*, *Philenoptera violacea*, *Spirostachys africana*, *Dalbergia melanoxylon*, *Colophospermum mopane*, *Pavetta gracillima*, *Rhoicissus revoilii*, *Senna petersiana*, *Maerua parvifolia*, *Grewia bicolor*, *Ehretia amoena*, *Tricalysia allenii*, *Euclea divinorum*, *Cleistochlamys kirkii, Strychnos madagascariensis*, *S. potatorum*, *Combretum apiculatum*, *C. collinum* subsp. *collinum*, *C. imberbe*, *C. mossambicense*, *C. zeyheri*, *Phyllanthus pinnatus*, *Hugonia orientalis*, *Grewia flavescens*, *Euclea natalensis* subsp. *angustifolia, Capparis tomentosa, Cissus cornifolia, Erythrococca menyharthii* and *Thilachium africanum.* In one stand *Combretum collinum* subsp.

collinum and *C. mossambicense* had a cover abundance up to 10%, and *Grewia bicolor* had a similar abundance in two stands.

The herbaceous groundcover consisted mainly of grasses with very few herbs in between. In most stands *Urochloa mosambicensis* was the dominant grass species. *Eragrostis pallens* and *Pogonarthria squarrosa* were prominent in some areas, and *Panicum maximum* was common throughout but only in shady places.

The height of the top canopy trees varied from 8 to 12 m in two stands, 9 to 17 m in four, to 14 to 20 m in two. Canopy cover was 1 to 4% in four stands and 5 to 15% also in four. The trees were more or less evenly scattered in some areas, variously grouped or irregularly distributed in others.

The second tree layer was always rather staggered with heights of 4 to 6 m in three stands, 5 to 8 m in two, and 6 to 12 m also in three. The subcanopy cover was 5% in two stands, 10 to 20% in four, and 25% and 40% in one each. Open patches of grassland or grassland with scattered shrubs occurred throughout. These varied in size and shape from 500 to 2,000 m^2 in some areas, to 1 ha or more in others.

The cover of the shrub layer was 2 to 5% in four stands and 6 to 10% also in four. The shrubs were irregularly scattered, loosely grouped or clumped, occurring mainly among the taller woody vegetation and to a lesser extent in the open spaces.

The total woody cover was 15 to 25% in six stands, and 35% and 60% in one each.

The cover abundance of the herbaceous groundcover was 15 to 30% in three stands, 50 to 65% in four, and 75% in one.

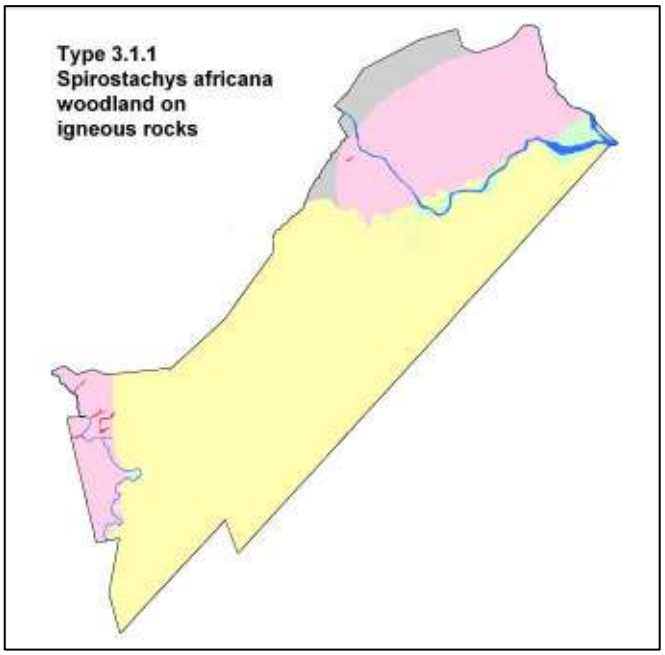
The structure of this vegetation type was classified as wooded grassland, bordering on open woodland in one stand.

Recent elephant damage was in most stands moderate. In three stands up to 10 standing dead trees could be seen from one point and one to three fallen ones.

Subtype 3.1.1 *Spirostachys africana* Woodland on Igneous Rocks

1 Stand: 215.

This vegetation type was only recorded once within the igneous rock belt in the western boundary area. Five areas were mapped in this portion, plus one additional area within the northern igneous rocks to the west of the Runde River. The total extent was approximately 3 km^2.



The topography was a flat broad valley between two chains of hills. The geology was rhyolite and the soils a dark coloured clay.

Top and subcanopy trees consisted essentially of *Spirostachys africana* interspersed with occasional *Combretum imberbe* and *C. hereroense* var. *hereroense* specimens.

The shrub layer was mainly made up of *Colophospermum mopane*, other tree species fairly conspicuous in the shrub layer were *Combretum imberbe*, *C. hereroense* var. *hereroense*, *Diospyros mespiliformis*, *Peltophorum africanum* and *Philenoptera violacea* as well as *Spirostachys africana*. Typical shrub species were *Allophylus rubifolius* var. *rubifolius*, *Coffea racemosa*, *Dichrostachys cinerea* subsp. *africana*, *Euclea divinorum*, *Flueggea virosa* subsp. *virosa*, *Monodora junodii*, *Neoholstia tenuifolia* var. *tenuifolia* and *Ochna inermis*.

Tree heights in the top canopy were up to 15 m and the heights in the subcanopy were 5 to 12 m. The cover for the top canopy and subcanopy was 5% and 12% respectively. The shrub layer was sparse, mainly below 1%, and total woody cover was approximately 18%. The herbaceous groundcover was dense, 90 to 100% over most of the area, and consisted mainly of *Urochloa mosambicensis* and *Panicum maximum* under trees. The structure was wooded grassland.

There were a fair number of standing and knocked over dead trees and numerous open spaces. Some recent elephant damage to the woody vegetation was observed.

Type 4. *Colophospermum mopane* Woodland on Igneous Rocks, Malvernia Sediments and Alluvium

Mopane woodland was a common vegetation type throughout the Park. It was always instantly recognized because of the exclusive dominance of *Colophospermum mopane* normally in all layers. In its undisturbed state it occurs as a close woodland, with the trees tightly spaced and ascending crowns. Other canopy species were few and normally widely scattered. The lower layers had a larger variety of associate species, also widely dispersed. The *Colophospermum mopane* in the subcanopy and shrub layers were mainly mutilated broken down and regrowing mature specimens.

Mopane woodland occurred on the basalt and granophyre areas in the north and in the hilly country of the southwestern boundary area, as well as in many places on the Malvernia Beds and occasionally on alluvial terraces. It was mainly found on flat or gently undulating land but also on hillsides and escarpments. The underlying geology was basalt, dolerite, gabbrodiorite, syenite, trachyte, rhyolite, microgranite, calcrete, sandstone and other Malvernia deposits and alluvium. The soils were mainly clays, loamy clays and clay loams, but also sandy clay loams, sandy loams and loamy sands. The structure varied from wooded grassland or wooded shrubland in the most degraded areas to open woodland. Woodland was seen in only a few places.

In accordance with environmental factors nine types of mopane woodland were recognized:

Type 4.1 – Mopane woodland on basalt and other igneous rocks on heavy clay soils
  Subtype 4.1.1 – Mopane mixed woodland along drainage lines through heavy clay soils
Type 4.2 – Mopane woodland on northern igneous rocks on clay loam soils
Type 4.3 – Mopane woodland on southern igneous rocks on clay loam soils
Type 4.4 – Mopane woodland with *Pseudolachnostylis maprouneifolia* on southern igneous rocks on loam soils
Type 4.5 - Mopane woodland on Malvernia heavier textured loam to clay soils
Type 4.6 – Mopane woodland on Malvernia pebbly loam soils
  Subtype 4.6.1 – Mopane mixed woodland on Malvernia steep hills and escarpments
Type 4.7 – Mopane woodland on Malvernia sands
Type 4.8 – Mopane – *Spirostachys africana* woodland along drainage lines
  Subtype 4.8.1 – *Androstachys johnsonii* woodland along drainage lines
Type 4.9 – Mopane woodland on alluvium

Associate tree species which occurred in all mopane types were *Acacia nigrescens*, *Cassia abbreviata* subsp. *beareana*, *Combretum apiculatum*, *C. hereroense* var. *hereroense, Dalbergia melanoxylon* (mainly as a shrub), *Markhamia zanzibarica* and *Strychnos madagascariensis*. Shrub species recorded

throughout were *Cissus cornifolia*, *Combretum mossambicense* (sometimes a liana), *Dichrostachys cinerea* subsp. *africana*, *Flueggea virosa* subsp. *virosa*, *Grewia bicolor, Maerua parvifolia* (except on heavy clays) and *Phyllanthus pinnatus*. These species were often common in the various types, but not always. In some types they were either typically scarce or typically very common. Some of the sub-types could be recognized by indicator species, others by typical species assemblages only. The total extent of *Colophospermum mopane* woodland in the Park is approximately 2154 km^2 or 42% of the total area.

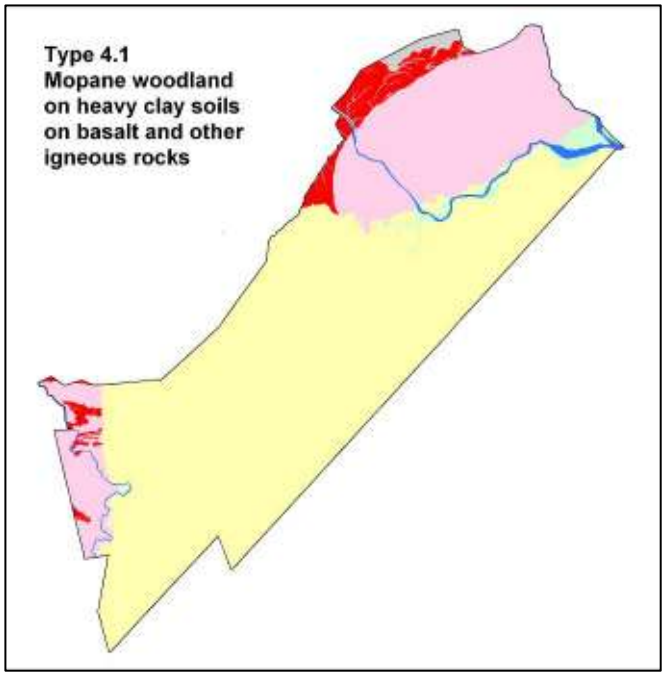
Type 4.1. Mopane Woodland on Basalt and Other Igneous Rocks on Heavy Clay Soils

9 Stands: 13, 33, 138, 142, 202, 209, 220, 224, 250.

This woodland type was found in both the north, where it consisted of a continuous block which extended along the northwestern boundary to either side of the Runde River, and the south of the Park, where it occurred as a number of small patches within the southern igneous rock complex. Its total extent was 194 km^2. Nine stands were investigated.

The topography was level (three stands) to slightly undulating gentle slopes (five stands), except for one stand which was on a small hill in the north of the Park (Stand 209). The underlying geology was basalt in five stands, dolerite in two and syenite and trachyte in one each. The soils were clays in eight stands and loamy clay in one. Large and medium sized termitaria were recorded in three stands each, and small ones in one stand, all at a density of 1 to 5 per ha. In two stands no termitaria were seen. In most stands there were occasional rock outcrops and the small hill in the north was very rocky.

Colophospermum mopane was dominant in all layers. A typical but widely scattered top canopy associate species was *Combretum imberbe*. Rarely encountered large tree species were *Adansonia digitata*, *Berchemia discolor* and *Kirkia acuminata*.



Common associate species in the second tree layer were *Combretum apiculatum*, *C. hereroense* var. *hereroense* and *C. imberbe*. *Combretum imberbe* was the most common one and reached a cover of 7% in one stand. Slightly less common were *Dalbergia melanoxylon* and *Philenoptera violacea* which were recorded in two thirds of the stands. Typical but less frequently encountered associate species were *Acacia nigrescens*, *Cassia abbreviata* subsp. *beareana, Markhamia zanzibarica* and *Pterocarpus brenanii*.

Commonly recorded shrub species were *Dichrostachys cinerea* subsp. *africana*, *Flueggea virosa* subsp. *virosa* and *Cissus cornifolia*. Typical but less widespread shrubs were *Combretum mossambicense*, *Grewia bicolor* and *Rhoicissus revoilii*. All tree species recorded in the second tree layer also contributed toward the shrub layer.

Typical for this vegetation type was the common presence of *Combretum imberbe*, the absence of *Maerua parvifolia* and the low woody species count (between 9 and 21 species for eight stands).

The herbaceous groundcover varied considerably in species composition and the proportion of forbs it contained. All of the following grass species were dominant in some localities: *Andropogon*

fastigiatus, *Aristida congesta*, *A. rhiniochloa*, *A. scabrivalvis*, *Chloris virgata*, *Digitaria milanjiana*, *Eragrostis pallens*, *E. superba*, *Panicum maximum*, *Pogonarthria squarrosa*, *Schmidtia pappophoroides*, *Sorghum versicolor* and *Urochloa mosambicensis*. Occasionally there was no dominant grass species and various mixtures of the above could occur. Forbs observed were *Calostephane divaricata*, *Ceratotheca sesamoides*, *Kyllinga alba*, *Tephrosia purpurea* subsp. *leptostachya*, *T. villosa* subsp. *ehrenbergiana* and *Waltheria indica*.

Height of the top canopy trees was up to 15 m in two stands, and 17 to 20 m in the others. Canopy cover was 1% or less in five stands and 3% in one. In three stands no top canopy trees were noted.

Tree height in the second layer was mainly 3 to 8 m, occasionally up to 12 m. The cover was up to 20% in seven stands, 25% in one, and 40 to 50% also in one. In all stands this layer formed the bulk of the woodland. Trees were fairly evenly spaced or patchy, most of them were mutilated or regenerating, multi-stemmed original trees. In some areas the spacing of the damaged and regenerating trees was still the one of the original woodland. In the better wooded stands the spaces devoid of trees were arranged in a fairly regular pattern and were from 50 to 100 m^2 in size. In the severely degraded stands open spaces of mainly grassland could be up to half a hectare.

The cover of the shrub layer was up to 10% in six stands and 11 to 25% in three. Shrubs were clumped or scattered occurring mainly in the parts still covered with trees.

Total woody cover varied from as low as 5 to 10% in one stand, to 15 to 30% in five and 45 to 60% in three.

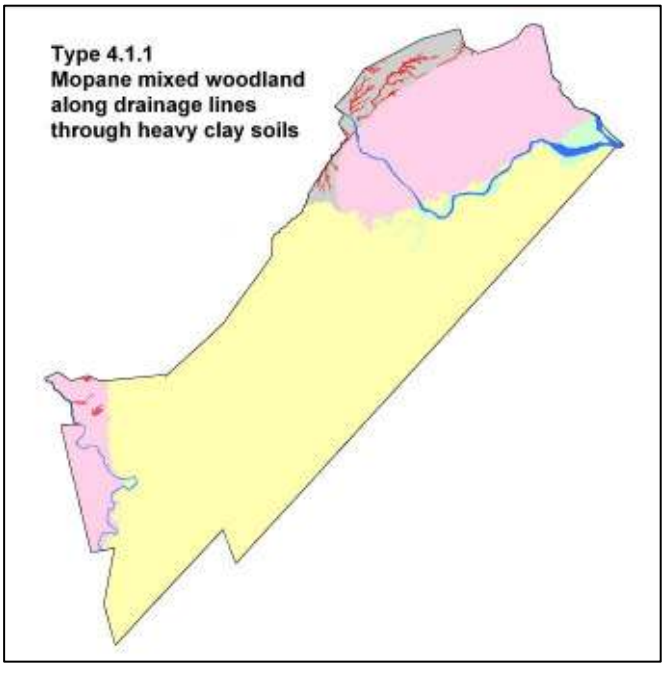
The herbaceous groundcover was up to 25% in one stand, 26 to 50% in four and 80 to 90% in two. In one stand the cover was 40% on the convex areas and up to 100% in the depressions, and in one stand the cover was not recorded. *Colophospermum mopane* seedlings were observed in numerous places.

The vegetation structure was wooded grassland in the stand with the lowest woody cover, open woodland over most of the area, and woodland in three stands.

Recent elephant damage was moderate in most stands, but long term damage was severe in all stands and extremely severe in a few. Almost all specimens of *Philenoptera violacea* were badly damaged. Characteristic species of this woodland type, such as *Commiphora africana*, *C. pyracanthoides*, *Ormocarpum trichocarpum*, *Pterocarpus brenanii* and *Rhoicissus revoilii,* were surprisingly scarce. There was much evidence of wood cutting in the northern boundary region.

Subtype 4.1.1. Mopane Mixed Woodland Along Drainage Lines Through Heavy Clay Soils

No stands: (not sampled).



Within the *Colophospermum mopane* woodland on heavy clay soils the drainage lines show up clearly as a different vegetation unit. The total extent was 23 km^2. No stands were recorded.

All the species noted were typical species of Type 4.1 Mopane Woodland on Basalt and Other Igneous Rocks on Heavy Clay Soils, but the proportions in which they occurred were different. *Colophospermum mopane* was widely scattered and the common three species were *Acacia nigrescens, Combretum hereroense* var. *hereroense* and *C. imberbe. Philenoptera*

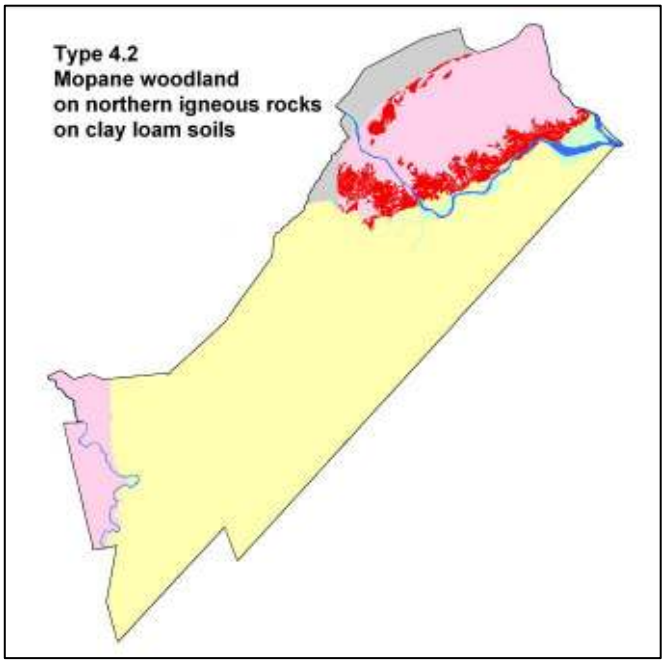
violacea was common in some places and scarce in others. *Flueggea virosa* subsp. *virosa* was the most frequently occurring shrub.

Type 4.2. Mopane Woodland on Northern Igneous Rocks on Clay Loam Soils

8 Stands: 2, 6, 185, 200, 204, 257, 261, 292.

This type of mopane woodland was confined to the granophyre areas in the north of the Park, where it was observed forming a patchy belt along the southern, western and northern edge of the complex, including a sizeable stand in the vicinity of the Massasanya Dam. The total area covered was approximately 230 km^2. Eight stands were investigated.

The topography consisted of flat or gently undulating either bottom or upland plains. The underlying geology was syenite (four stands), and granite, granophyre, rhyolite and trachyte in one stand each. The soils were clays in two stands, loamy clays in three, clay loams in two and sandy loam in one stand. Large termitaria were recorded in four stands and medium sized ones also in four, all at a density of 1 to 5 per ha. Four stands were devoid of rock, in most of the others there were occasional low outcrops, and in one rock cover was up to 50%.



Colophospermum mopane was the dominant woody species in all layers. Other occasional top canopy tree species were *Acacia welwitschii* subsp. *delagoensis*, *Adansonia digitata*, *Combretum imberbe* and *Kirkia acuminata*.

Fairly common associate species in the second tree layer were *Combretum apiculatum*, *C. hereroense* var. *hereroense* and *Markhamia zanzibarica*. Slightly less common ones were *Acacia nigrescens*, *Cassia abbreviata* subsp. *beareana*, *Drypetes mossambicensis* and *Spirostachys africana*.

The most common species in the shrub layer were *Cissus cornifolia*, *Flueggea virosa* subsp. *virosa*, *Maerua parvifolia, Markhamia zanzibarica, Phyllanthus pinnatus* and *Thilachium africanum*. Fairly common species were *Boscia angustifolia* var. *corymbosa, Combretum apiculatum*, *C. mossambicense* and *Drypetes mossambicensis.* Occasionally recorded species were *Acacia erubescens*, *A. welwitschii* subsp. *delagoensis*, *Cassia abbreviata* subsp. *beareana*, *Combretum hereroense* var. *hereroense*, *Hippocratea crenata*, *Ochna inermis*, *Spirostachys africana* and *Vitex ferruginea* subsp. *amboniensis*.

Woody species which were typically present in most of the stands but absent or infrequently present in most of the other types were *Drypetes mossambicensis*, *Phyllanthus pinnatus* and *Thilachium africanum*, and to a lesser extent *Boscia angustifolia* var. *corymbosa*, *Rhigozum zambesiacum* and *Vitex ferruginea* subsp. *amboniensis*. Most of the stands contained three to five of these species. Similar combinations could occasionally occur in other types, but if so the rest of the assemblage was always different.

The groundcover consisted mainly of grasses. Frequently dominant species were *Aristida adscensionis*, *A. rhiniochloa*, *Digitaria milanjiana*, *Enneapogon cenchroides*, *Pogonarthria squarrosa* and *Urochloa mosambicensis*. Locally dominant grass species were *Aristida meridionalis*, *Eragrostis pallens*, *Heteropogon contortus*, *Sporobolus festivus* and *Tetrapogon tenellus*. Noticeable forbs were

Hemizygia bracteosa, *Indigofera flavicans*, *Limeum argute-carinatum*, *Tephrosia villosa* subsp. *ehrenbergiana* and *Vernonia poskeana*.

Tree height of the mature trees was up to 20 m in most stands, 16 to 18 m in two, and up to 24 m in one. Canopy cover was 1% or less in five stands, 2 to 5% in two, and 7 to 10% in one.

Tree height in the second layer was generally from 3 to 7 m, occasionally up to 8 or 10 m. Canopy cover was 1 to 5% in two stands, 10 to 20% in five, and 30% in one.

The cover of the shrub layer was up to 10% in five stands, 15 to 20% in two, and up 55 to 60% in one.

Total woody cover was 15 to 25% in three stands, 25 to 35% in four and 60% in one stand. In the two stands where the canopy cover of the second tree layer was 5% or below (Stands 261 and 292), mature trees had been knocked down to shrub level and almost all of the total woody cover was contained in the shrub layer.

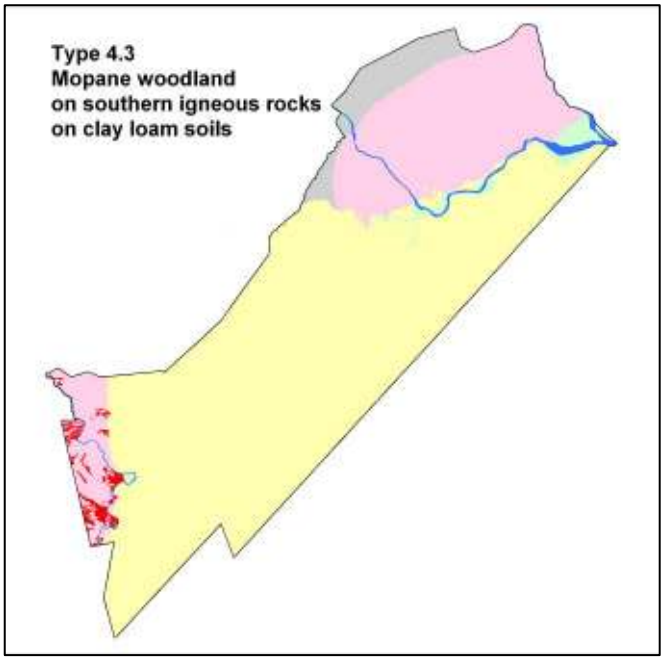
The cover of the herbaceous groundcover was 5 to 20% in two stands, 30 to 40% in five, and 70% in the remaining one.

The vegetation structure was wooded grassland in some of the areas, open woodland over most of it, and in some places grading into woodland.

In this woodland type the process of tree elimination by elephant was particularly well illustrated. In most areas there were very few large trees left, mostly widely scattered but occasionally still clumped. At least half of the large living trees had bark damage. The original canopy appeared to have been gradually lowered and simultaneously fragmented. In different stands the canopy was at different heights, in some it had been reduced to a level where it constituted the shrub layer. The more degraded the woodland the larger the areas of grassland between the woody vegetation. In one stand (Stand 261) there were areas in which degradation achieved a parkland effect of scattered large trees with grassland in between. In other areas the open spaces were invaded by secondary woodland, with *Combretum apiculatum* the main invading species.

Type 4.3. Mopane Woodland on Southern Igneous Rocks on Clay Loam Soils

5 Stands: 19, 23, 25, 27, 66.



This subtype was found in the igneous rock complex in the southwest of the Park occurring in numerous relatively small scattered patches. Its total extent was approximately 41 km^2. Five stands were investigated.

The topography in the vicinity of one stand consisted of a level bottom plain, in the other four of gentle slopes one of which was gently undulating. The geology was basalt in two stands, rhyolite also in two and gabbrodiorite in one. The soils were clay in one stand, loamy clay in two, and sandy clay loam also in two. Large termitaria were noted in four stands and medium sized ones in one, all at a density of 1 to 5 per ha.

In all stands *Colophospermum mopane* was the

prominent canopy tree. An occasionally occurring tree species was *Spirostachys africana,* and *Combretum imberbe* and *Manilkara mochisia* were noted in one stand each.

The most common subcanopy tree was also *Colophospermum mopane*, generally with a cover of 15 to 30%. Fairly common associate species were *Combretum apiculatum* and *Spirostachys africana*, the former with a cover of up to 8% in one stand and the latter of up to 8% in two. Typical but less common associate trees were *Acacia nigrescens*, *Combretum hereroense* var. *hereroense* and *Terminalia prunioides*.

The shrub layer was generally poorly developed, and where it had a cover of up to 25% mutilated mature mopane trees were the main component. *Colophospermum mopane* was over most of the area the most common species, with a cover of up to 10% in all stands apart from the one of 25% mentioned above. Other common or fairly common tree species in the shrub layer were *Combretum apiculatum*, *C. hereroense* var. *hereroense*, *Commiphora africana*, *Dalbergia melanoxylon* and *Spirostachys africana*. The most common and widespread shrubby species was *Dichrostachys cinerea* subsp. *africana*. Other common shrubs were *Euclea racemosa* subsp. *schimperi*, *Flueggea virosa* subsp. *virosa*, *Grewia caffra* and *Maerua parvifolia*.

The cover of the herbaceous layer consisted mainly of grasses. The most common grass species recorded was *Schmidtia pappophoroides*, other grasses noted were *Aristida congesta*, *Bothriochloa insculpta*, *Enteropogon macrostachyus*, *Eragrostis pallens*, *E. superb*a and *Urochloa mosambicensis*. The sedge *Kyllinga alba* was frequently present and *Tephrosia villosa* subsp. *ehrenbergiana* and *Waltheria indica* were common forbs.

The height of the canopy species was up to 15 m in two stands and 18 to 20 m in three. Canopy cover was less than 1% in three stands, and 2 to 5% in two.

The trees in the sub-canopy were 3 to 8 m tall, exceptionally up to 10 m, and the cover was 20 to 30% in all stands.

The cover abundance of the shrub layer was 1 to 10% in four stands and 25% in one.

The total woody cover was 25 to 30% in two stands and 40 to 50% in three.

The cover of the herbaceous layer varied from 5% to about 30%.

The vegetation structure varied from open woodland to woodland.

Elephant damage was severe as in most mopane types.

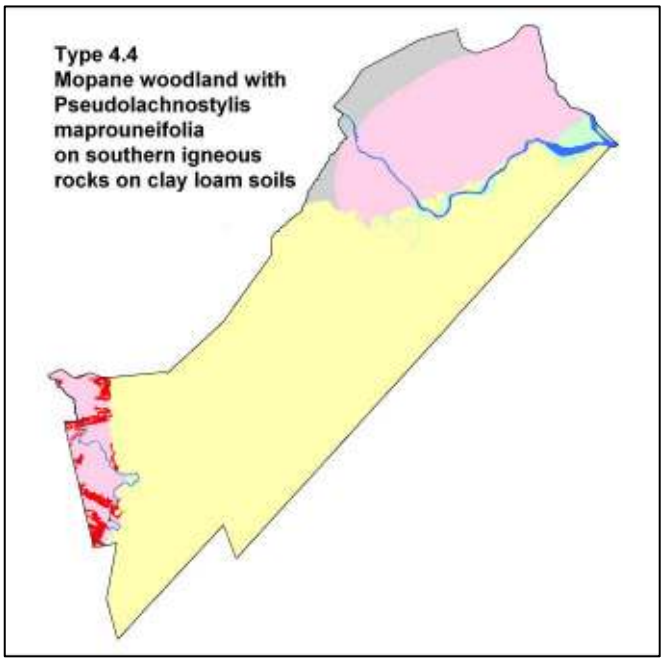
Type 4.4. Mopane Woodland with *Pseudolachnostylis maprouneifolia* on Southern Igneous Rocks on Loam Soils

7 Stands: 20, 21, 34, 58, 216, 218, 223.

Like Type 4.3 this type was only found within the igneous rock complex in the southwest of the park where it occurred in numerous small patches. The total area was 58 km^2. Seven stands were investigated.

The topography was a gentle occasionally gently undulating slope in four stands and a flat upland plain, a flat ridge top and hilly ground in one stand each. The geology was syenite in four stands, rhyolite in two and dolerite in one. The soils were sandy loam in three stands, sandy clay loam in two, and clay loam and loam in one stand each. Termitaria were recorded in six stands and no assessment was made for one stand. In three stands there were large ones (> 2m) at a density of 1 to 5 per ha, in

two stands there were medium (1 to 2 m) ones at the same density and in one stand there were medium sized anthills at a density of more than 5 per ha. There were occasional rock outcrops of either large boulders or smaller ones in six stands, and outcropping rock over about 30% of the surface in one.



Colophospermum mopane was the most frequently recorded mature canopy tree, rarely noted ones were *Afzelia quanzensis*, *Kirkia acuminata*, *Peltophorum africanum*, *Pseudolachnostylis maprouneifolia* and *Xeroderris stuhlmannii*.

The most commonly recorded tree in the subcanopy was *Combretum apiculatum*, having a cover of up to 40% in two stands, 20% in three and up to 8% in two. *Colophospermum mopane* also occurred in all stands and had a cover of up to 10% in three of them. Other fairly common but less widespread trees were *Cassia abbreviata* subsp. *beareana*, *Combretum zeyheri*, *Lannea schweinfurthii* var. *stuhlmannii*, *Peltophorum africanum*, *Pseudolachnostylis maprouneifolia*, *Strychnos madagascariensis* and *Terminalia sericea*. Of these *Combretum zeyheri* had a cover of up to 20% in one stand. Occasionally recorded but nevertheless typical tree species were *Acacia erubescens*, *Guibourtia conjugata*, *Lannea schweinfurthii* var. *stuhlmannii*, *Pteleopsis myrtifolia* and *Ziziphus mucronata*.

Young tree species, or with reference to mopane mutilated mature trees, made up a substantial portion of the shrub layer. The two most common and widely distributed species were *Combretum apiculatum* and *Colophospermum mopane*, both had a cover of up to 10% in three stands. Other fairly common tree species in the shrub layer were *Cassia abbreviata* subsp. *beareana*, *Dalbergia melanoxylon*, *Terminalia sericea* and *Xeroderris stuhlmannii*. Occasionally occurring ones were *Combretum zeyheri*, *Commiphora africana*, *Lannea schweinfurthii* var. *stuhlmannii*, *Pseudolachnostylis maprouneifolia* and *Strychnos madagascariensis*. The most common shrub species was *Dichrostachys cinerea* subsp. *africana*, also quite common was *Combretum mossambicense* (can be a liana). Other fairly common shrubs were *Cissus cornifolia*, *Flueggea virosa* subsp. *virosa* and *Tricalysia allenii* and less common but typical species were *Euclea divinorum*, *Grewia caffra* and *Hugonia orientalis* (can be a liana).

The groundcover was mainly grass. The main grass species were *Aristida rhiniochloa*, *Digitaria milanjiana*, *Eragrostis superba*, *Melinis repens*, *Pogonarthria squarrosa*, *Schmidtia pappophoroides* and *Urochloa mosambicensis*. Common herbs were *Monechma debile*, *Sida cordifolia* and *Waltheria indica*.

Tree height in the canopy was up to 15 m in one stand, 18 m in two and up to 20 m in four. Canopy cover was less than 1% in all stands.

In the subcanopy the tree height was normally 3 to 6 m, occasionally up to 8 m. The cover abundance was 5% in one stand, 15 to 20% in two and 30 to 50% in the remaining four.

The cover of the shrub layer was below 10% in two stands, 10 to 12% in one, 20 to 30% in two stands and 30 to 40% also in two.

Total woody cover was 10 to 20% in one, 20 to 25% in two, and 30 to 60% in the others.

The herbaceous groundcover was sparse in two stands (about 15%), in the others it looked like a continuous grass cover from a distance but close up it consisted of individual tufts and the cover was an estimated 40 to 70%.

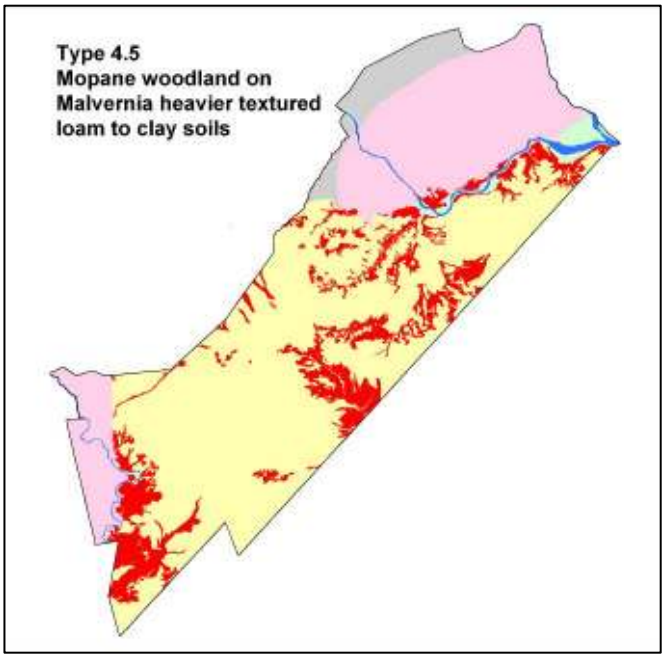
The vegetation structure was wooded grassland in two stands and open woodland in the remaining ones.

Accumulated elephant damage over a prolonged period was severe, however relatively little recent damage was observed.

Type 4.5. Mopane Woodland on Malvernia Heavier Textured Loam to Clay Soils

13 Stands: 5, 11, 46, 99, 111, 149, 159, 160, 169, 228, 256, 275, 288.

This type of mopane woodland was found scattered throughout the Malvernia Beds from the Mwenezi River in the west to just north of the Runde River in the east, mainly occurring in the lower parts of the landscape. The total extent was approximately 633 km^2. Thirteen stands were investigated.



The topography consisted mainly of flat bottom plains (seven stands), gently sloping or occasionally gently undulating land (four stands), or rarely upland plains (two stands). The geology was entirely Malvernia Beds. The soils were clay loam in five stands, loamy clay and sandy clay loam each in two stands, with one stand each on clay, loam and sandy loam (for one stand no assessment was recorded). Large termitaria were recorded in six stands and medium sized ones in two, all at a density of 1 to 5 per ha. In five stands no termitaria were noted. There was no rock in any of the stands, but surface gravel was present in some.

Colophospermum mopane was the dominant species in all layers. *Spirostachys africana* was occasionally recorded in the top canopy and *Combretum imberbe* and *Sclerocarya birrea* subsp. *caffra* rarely.

Fairly common associate tree species in the second tree layer were *Acacia nigrescens* and *Spirostachys africana,* and slightly less common were *Combretum apiculatum*, *C. hereroense* var. *hereroense* and *Strychnos potatorum*.

The most common species in the shrub layer were *Flueggea virosa* subsp. *virosa* and *Maerua parvifolia*. Other fairly common species were *Cissus cornifolia*, *Combretum apiculatum*, *C. hereroense* var. *hereroense*, *Dichrostachys cinerea* subsp. *africana, Euclea divinorum*, *E. racemosa* subsp. *schimperi* and *Markhamia zanzibarica*. Typical but less common species were *Acacia nigrescens*, *Cassia abbreviata* subsp. *beareana, Cleistochlamys kirkii*, *Combretum mossambicense*, *Dalbergia melanoxylon*, *Drypetes mossambicensis, Grewia bicolor*, *G. flavescens, Hippocratea buchananii*, *H. crenata*, *Lannea schweinfurthii* var. *stuhlmannii*, *Phyllanthus pinnatus*, *Spirostachys africana*, *Strychnos potatorum* and *Thilachium africanum*.

The species composition was intermediate between that of Type 4.1, where the soils were heavy clays, and Type 4.7 where the soils were sandy. However, there was much species overlap and the

differences were subtle, often only expressed in the proportions in which the species occurred rather than presence or absence. *Maerua parvifolia* was common in this type (recorded in 80% of the stands) and not recorded in Type 4.1. *Cleistochlamys kirkii*, *Euclea divinorum*, *Grewia flavescens*, *Lannea schweinfurthii* var. *stuhlmannii*, *Phyllanthus pinnatus* and *Terminalia prunioides* were all typical species of this type, being recorded in between 30 to 50% of the stands but never in Type 4.1. *Euclea racemosa* subsp. *schimperi* and *Spirostachys africana* were fairly common in this type (recorded in 60 and 65% of the stands) but rarely in Type 4.1 (in 10% of the stands). *Combretum imberbe* was common in Type 4.1 (in 80% of the stands) but rare in this type (in 15% of the stands).

The main difference between this type (Type 4.5) and Type 4.7 was that in Type 4.7 *Xeroderris stuhlmannii* and *Terminalia sericea* were common (recorded in 70% and 55% of the stands respectively), yet in this type both were rare (15% of the stands). Conversely, *Acacia nigrescens* was fairly common in this type (present in 50% of the stands) but rare in Type 4.7 (in 15% of the stands). Looking at the entire species assemblage the three types were always distinct and often they could be recognized by a small group of typical species.

In two stands (Stands 5 and 288) *Salvadora persica* var. *pubescens* was recorded. In the areas where it occurred the *Colophospermum mopane* seemed to be particularly heavily damaged, with large trees reduced to ground level. In some places there were extensive open spaces with only small traces of mopane still visible.

The herbaceous ground cover consisted mainly of grasses. Generally the dominant grass species were *Aristida rhiniochloa*, *Digitaria milanjiana*, *Pogonarthria squarrosa* and *Schmidtia pappophoroides*. Locally dominant species were *Enneapogon cenchroides*, *E. scoparius*, *Eragrostis pallens*, *E. superba*, *Sporobolus panicoides*, and *Urochloa mosambicensis*. *Panicum maximum* was common throughout in shady places. Forbs noted were *Actiniopteris dimorpha* subsp. *dimorpha* (a fern), *Asparagus suaveolens*, *Barleria lancifolia*, *B. senensis*, *Crotalaria virgulata*, *Hemizygia bracteosa*, *Melhania forbesii*, *Sida cordifolia*, *Vernonia poskeana* and *Waltheria indica*.

Tree height of mature top canopy trees was 15 to 17 m in four stands, between 18 and 20 m in six, and up to 25 m in one. Canopy cover was below 1% in six stands, 5 to15% in four, and 20% in one. In two stands there were no mature trees recorded (Stands 46 and 99). In a few stands there were still fragments of the original canopy left showing the natural spacing with trees 7 to 10 m apart (Stands 149 and 275).

The height in the second layer was mostly 3 to 8 m, occasionally 10 to 12 m. The canopy cover was 1 to 5% in three stands, 8 to 20% in eight, and 25 to 30% in two.

The cover of the shrub layer was 7 to 13% in six stands, 15 to 28% in six and 55% in one. The portion of knocked down mature trees in the shrub layer was considerable, and any value of more than 10% cover was due to decimated large trees.

Total woody cover was 20 to 30% in four stands, 31 to 40% in five and 41 to 60% in four.

The herbaceous groundcover was extremely variable, 3 to 15% in seven stands, 20 to 30% in three, and 40 to 60% also in three.

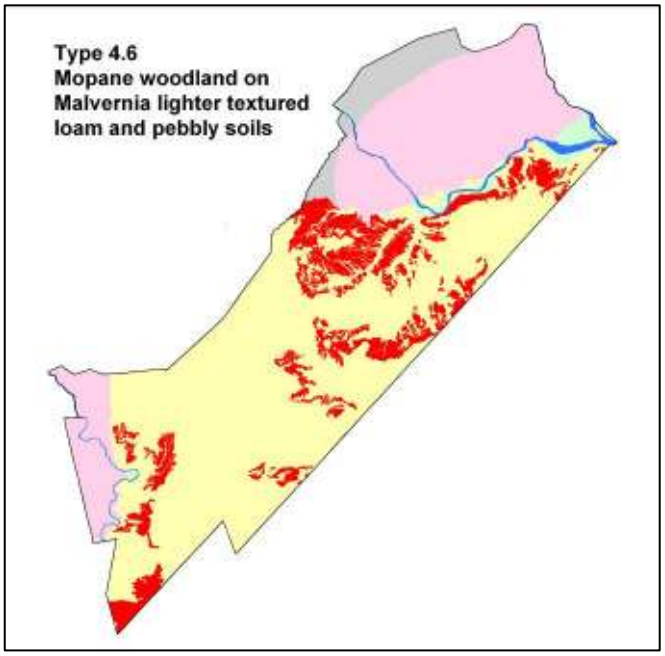
The vegetation structure was open woodland in nine stands and woodland in four.

Degradation was similar as described in the previous mopane types.

Type 4.6. Mopane Woodland on Malvernia Pebbly Loam Soils

25 Stands: 32, 38, 55, 56, 61, 62, 74, 75, 85, 130, 144, 145, 147, 150, 161, 176, 177, 178, 229, 236, 246, 291, 313, 317, 325.

This type of mopane woodland was found in all parts of the Malvernia Beds, from the southwestern tip of the park to immediately south of the Runde River, mainly occurring in the upper portions of the landscape. It covered numerous areas which varied in size from quite small to fairly large. The total extent of this vegetation type was approximately 583 km^2. Twenty-five stands were investigated.



The topography was gently undulating more or less flat land in nineteen stands, and gentle also undulating slopes of up to 10% in the remaining six stands. The underlying rock was sandstone of the Malvernia Beds. The soils were often gritty, occasionally with pebbles, and were surprisingly variable, clay loam in seven stands, loam in six, sandy clay loam in five, sandy loam in three, and clay also in three. In one stand the soil was not recorded. Small termitaria were recorded in four stands, medium ones in six and large ones in five, all at a density of 1 to 5 per ha. In ten stands no termitaria were noted. There were occasional rock outcrops and often but not always gravel and pebbles at the surface. The soils seemed to be skeletal and the ground surface looked different from the ones of the other types on Malvernia Beds.

The top canopy trees were almost always *Colophospermum mopane*, occasionally *Terminalia prunioides,* and rarely *Acacia nigrescens*, *Combretum apiculatum*, *C. hereroense* var. *hereroense*, *Peltophorum africanum* and *Spirostachys africana*. In a few areas *Terminalia prunioides* was dominant, in one stand with a cover of up to 20%. In one stand *Spirostachys africana* had a cover of approximately 8%.

The second tree layer was generally sparse. Again *Colophospermum mopane* was the dominant tree species, with cover of up to 10% in five stands, up to 25% in three and up to 50% in one stand. The most common associate species was *Terminalia prunioides* with a cover of up to 10% in two stands. Also common trees were *Combretum apiculatum* and *C. hereroense* var. *hereroense. Combretum apiculatum* had a cover of about 8% in one stand and one of up to 25% also in one. *Combretum hereroense* var. *hereroense* had a cover of up to 10% in three stands and up to 25% in one stand. Fairly common trees were *Acacia nigrescens* and *Spirostachys africana,* the former was recorded in nine stands and the latter in seven.

The cover of the shrub layer was extremely variable from 4 to 75%. *Colophospermum mopane* was dominant in most stands, in five of them with a cover of 5 to 25%, also in five from 26 to 50%, and in three stands the cover was up to 70%. Other tree species common in the shrub layer were *Combretum hereroense* var. *hereroense*, *Dalbergia melanoxylon* and *Terminalia prunioides*. *Combretum hereroense* var. *hereroense* had a cover of approximately 8% and 20% each in one stand. *Combretum apiculatum* was only slightly less common, also with a cover of about 8% and 20% each in one stand. *Bolusanthus speciosus* and *Zanthoxylum humile* were recorded in about 40% of the stands, and *Balanites aegyptiaca*, *Cassia abbreviata* subsp. *beareana*, *Commiphora africana*, *Diplorhynchus condylocarpon*, *Ozoroa paniculosa* var. *paniculosa*, *Pappea capensis*, *Strychnos madagascariensis* and *Terminalia sericea* were noted in 20 to 30% of them. Of these *Balanites aegyptiaca* had a cover

of about 8% in one stand. An often common and typical shrub species for this vegetation type was *Acacia exuvialis*, a plant which in Zimbabwe is only recorded in the Gonarezhou National Park. It occurred in most stands, occasionally fairly scarce but in two stands with a cover of about 10% and in one of up to 20%. Also very common shrubs were *Dichrostachys cinerea* subsp. *africana*, *Grewia bicolor* and *Maerua parvifolia,* of these *Dichrostachys cinerea* subsp. *africana* had a cover of approximately 8% in one stand. Other common shrubby species were *Euclea racemosa* subsp. *schimperi*, *Gymnosporia pubescens* and *Ormocarpum trichocarpum*. Fairly common ones were *Cissus cornifolia*, *Flueggea virosa* subsp. *virosa*, *Jasminum stenolobum* and *Mundulea sericea* (in 32 to 48% of the stands). Of these *Mundulea sericea* had a cover of up to 7% in two stands. Occasionally recorded but typical shrub species were *Ehretia amoena, Euclea divinorum*, *Grewia lepidopetala, Hippocratea buchananii, Rhigozum zambesiacum* and *Ximenia americana* var. *microphylla*.

The groundcover consisted largely of grasses. Dominant grass species in many places were *Enneapogon scoparius* and *Schmidtia pappophoroides*. Less frequently dominant were *Andropogon gayanus*, *Cymbopogon caesius*, *Heteropogon contortus* and *Pogonarthria squarrosa*. Occasional locally dominant grass species were *Aristida adscensionis*, *A. congesta*, *Bothriochloa radicans*, *Digitaria eriantha, D. milanjiana*, *Eragrostis cylindriflora*, *E. superba*, *Panicum maximum* and *Urochloa mosambicensis*. Forbs recorded were *Endostemon tenuiflorus*, *Gnidia chrysantha*, *Indigofera schimperi*, *Seddera suffruticosa* and *Waltheria indica*.

The trees were typically stunted, mostly up to 8 or 10 m tall, seldom between 10 and 15 m. Canopy cover was zero in nine stands, less than 1% in seven, 1 to 5% also in seven, and 15 to 30% in two.

The tree height in the second layer was 3 to 7 m. Canopy cover was less than 1% in three stands, 1 to 5% in eleven, 6 to 15% in seven, 16 to 20% in one, and 40 to 50% also in one, and in two stands there was no second canopy.

The cover in the shrub layer was 1 to 10% in four stands, 11 to 25% in eleven, 26 to 50% in three, and 51 to 75% in seven.

Total woody cover was 3 to 8% in one stand, 11 to 25% in seven, 26 to 50% in eight and 51 to 80% in nine.

The herbaceous groundcover was below 1% in one stand, 1 to 5% in three, 6 to 10% in two, 11 to 25% in six, 26 to 50% in ten and 51 to 75% in two, and there was no record for one stand.

The structure of this vegetation type was wooded grassland or open shrubland. In the stands with a higher woody cover it bordered on shrubland.

This was one of the most degraded vegetation types in the Park. Top canopy cover was zero or below 1% in seventeen out of twenty-five stands and below 5% in another seven. Only two stands had a cover of 15 to 30%. The high cover values of *Colophospermum mopane* in the shrub layer and to a lesser extent in the subcanopy, was due to the large number of mature trees which had been mutilated and decimated down to the lower strata.

Subtype 4.6.1. Mopane Mixed Woodland on Malvernia Steep Hills and Escarpments

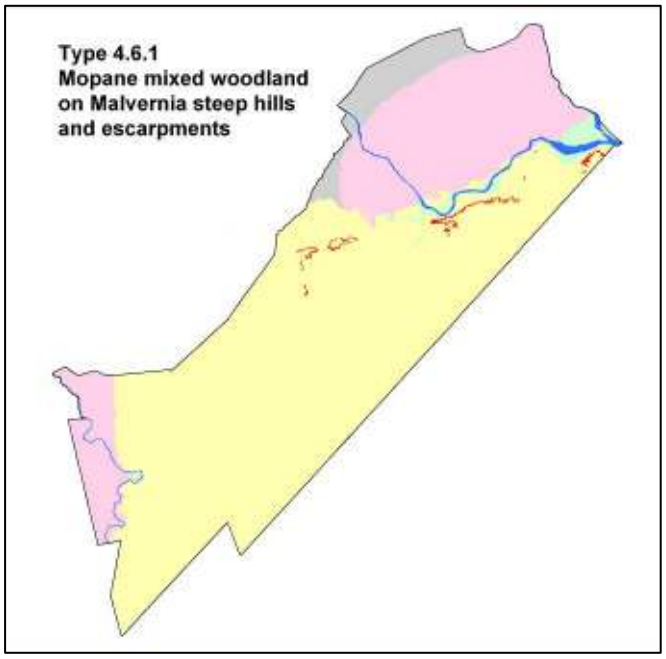
11 Stands: 151, 153, 154, 251, 253, 255, 265, 281, 286, 300, 327.

This subtype of mopane woodland was similar to Type 4.6. It had the same geology and shared a number of species with it, but occurred on escarpments and hillsides and contained some species which were not recorded on flat ground. It was found in the northern portion of the Park on the slopes of Nyamatongwe hill, on the Chilojo escarpment, some hills near Marumbini and on a small hill some

2 km south of the Runde River in the Chitove area. The overall extent of the subtype was 15 km^2. Eleven stands were investigated.

The topography consisted of moderate to steep slopes and escarpments, interspersed with small cliffs. The rock was sandstone as in Type 4.6. The soils were loamy clay, clay loam or loam in eight stands, and sandy loam, loamy sand and sand each in one stand. Termitaria were only noted in one stand (Stand 153) on the bottom slopes of Nyamatongwe hill. They were wider than 2 m and occurred at a density of 1 to 5 per hectare.

Most widespread and frequently recorded top canopy tree species were *Colophospermum mopane* and *Terminalia prunioides*. Occasionally recorded species were *Commiphora caerulea* (a new record for southern Zimbabwe) and *Kirkia acuminata*.



In the second tree layer *Colophospermum mopane* and *Terminalia prunioides* were again common throughout. Mopane had a cover of 10% or even more in five stands and *Terminalia prunioides* in one. *Androstachys johnsonii* was fairly common in most areas, except it was not recorded on the small hill near Chitove. On the slopes of Nyamatongwe it occurred in large dense patches in many places (Type 8.4). *Combretum apiculatum* and *C. hereroense* var. *hereroense* were common on Nyamatongwe and on the small hill. *Combretum hereroense* var. *hereroense* was not recorded in the other areas and *C. apiculatum* only occasionally so. Other fairly common and typical tree species were *Acacia senegal* var. *leiorhachis*, *Commiphora caerulea* and *Kirkia acuminata*. Slightly less common species were *Acacia nigrescens*, *Albizia brevifolia*, *Bolusanthus speciosus*, *Cassia abbreviata* subsp. *beareana*, *Commiphora edulis* subsp. *edulis, C. mollis, Pappea capensis* and *Sterculia rogersii*.

Colophospermum mopane was the most widespread and often also the most common tree species in the shrub layer with a cover of up to 8% in three strands. *Androstachys johnsonii* was equally widespread and fairly common, often with a more patchy distribution, and in one stand with a cover of about 7%. Other fairly common tree species in the shrub layer were *Acacia senegal* var. *leiorhachis*, *Combretum apiculatum*, *C. hereroense* var. *hereroense*, *Pappea capensis* and *Terminalia prunioides*. *Combretum apiculatum* had once and *C. hereroense* var. *hereroense* twice a cover of about 5 to 8%. Less common but still typical trees in this layer were *Acacia nigrescens*, *Albizia brevifolia*, *Bolusanthus speciosus*, *Commiphora caerulea* and *Ozoroa paniculosa* var. *paniculosa*. The most common and widespread shrubby species were *Acacia exuvialis*, *Grewia bicolor* and *Maerua parvifolia*. *Acacia exuvialis* and *Grewia bicolor* had each in one stand a cover of about 6%. Other slightly less common shrubs were *Dichrostachys cinerea* subsp. *africana*, *Euclea racemosa* subsp. *schimperi, Gardenia resiniflua* subsp. *resiniflua* and *Grewia flavescens*. Typical shrubs that were recorded in less than half of the stands were *Canthium glaucum* subsp. *frangula* var. *frangula*, *Cissus cornifolia*, *Cordia monoica*, *Grewia villosa* var. *villosa*, *Phyllanthus pinnatus*, *Thilachium africanum* and *Uvaria gracilipes*.

The groundcover consisted mainly of grasses. The generally dominant species was *Enneapogon scoparius. Schmidtia pappophoroides* was also fairly widespread and in some places dominant. Locally dominant species were *Aristida meridionalis*, *A. rhiniochloa*, *Chrysopogon serrulatus*,

Enneapogon cenchroides, *Eragrostis lehmanniana*, *Heteropogon contortus*, *Panicum maximum* and *Pogonarthria squarrosa*. *Lepidagathis scabra* was a forb recorded which was not seen elsewhere.

Species which were typical of this subtype and never recorded in Type 4.6 were *Albizia brevifolia*, *Androstachys johnsonii*, *Commiphora caerulea*, *C. edulis* subsp. *edulis*, *C. mollis*, *Cordia monoica*, *Gardenia resiniflua* subsp. *resiniflua*, *Grewia villosa* var. *villosa* and *Kirkia acuminata*. A species typical of the slopes and only once recorded on the flat land was *Grewia flavescens*. Species typical on flat land (Type 4.6) and of insignificant occurrence or absent on the slopes were *Dalbergia melanoxylon*, *Gymnosporia pubescens*, *Jasminum stenolobum* and *Ormocarpum trichocarpum*.

Top canopy trees were 12 to 16 m in height in most stands and up to 18 m in two. Canopy cover was 1% or less in six stands, 1 to 5% in four, and 25% in one.

The height of the trees in the second layer was 3 to 8 m, rarely up to 10 m. Canopy cover was 3 to 10% in six stands, 15 to 20% in three and 30% in two.

The cover of the shrub layer was 2 to 7% in seven stands and 8 to 20% in four.

Total woody cover was 10 to 25% in eight stands and 35% to 40% in the other three stands.

There was much bare ground on the slopes. The cover abundance of the herbaceous layer was 1 to 5% in two stands, 10 to 30% in five and 40 to 60% in four.

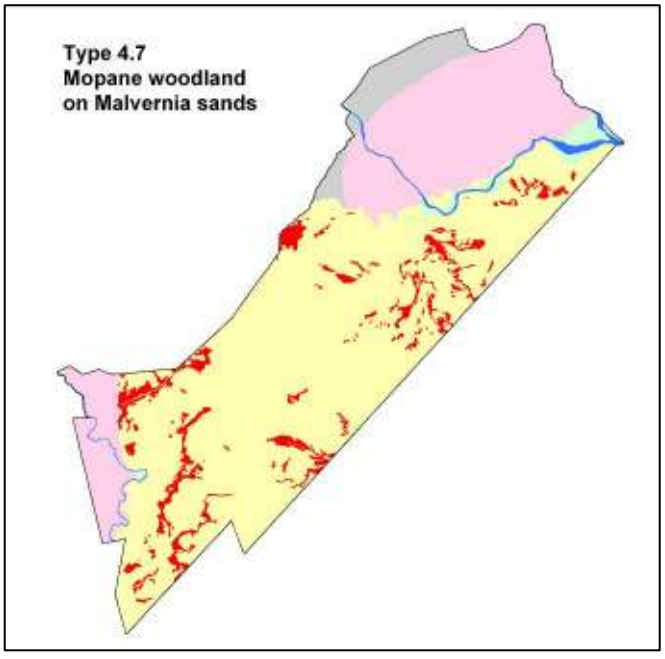
The structure of this vegetation type was wooded grassland in stands with the lowest total woody cover, open woodland in the ones with a cover of 20 to 40% and woodland in the one where the cover was estimated at 60%.

Elephant damage and degradation followed similar patterns as described for other mopane types. It was surprising to see how steep some of the slopes were on which recent elephant damage was observed.

Type 4.7. Mopane Woodland on Malvernia Sands

22 Stands: 26, 39, 43, 48, 51, 53, 63, 72, 73, 77, 106, 164, 166, 242, 243, 258, 259, 290, 304, 318, 323, 324.

This type was found in all parts of the Malvernia Beds, occurring in scattered patches mainly along the ecotone between the upland Malvernia sands and lowland heavier soils, but also on isolated outlying sand patches within the mopane lowlands. Twentytwo stands were investigated. Total extent was approximately 275 km^2.



The topography consisted of flat bottom or upland sand plains in fifteen stands, gentle slopes for five stands, and twice of a ridge top. The underlying geology was always Malvernia Beds, and soils were sandy loams in seven stands, loamy sand in nine, sandy clay loam in three, sand in two and clay loam in one. Large termitaria were recorded in four stands and medium sized ones also in four, all at a density of 1 to 5 per ha. In thirteen stands no termitaria

could be seen and in one stand no record was made. One stand had fairly frequent red conglomerate rock outcrops, all others had no rocks.

In most stands *Colophospermum mopane* was the sole large canopy tree, in eight stands with a cover of about 5% and in two up to 15%. Other occasional canopy trees were *Spirostachys africana* and *Xeroderris stuhlmannii*, and in four stands *Guibourtia conjugata* and *Sclerocarya birrea* subsp. *caffra* were present in the canopy.

Colophospermum mopane was the dominant species in the second tree layer and *Combretum apiculatum* was occasionally co-dominant, but more often a common and widespread associate species. Mopane had a cover of up to 50% in one stand, up to 25% in six and up to 10% in seven stands. *Combretum apiculatum* had a cover of up to 50% in two stands, up to 25% in four and up to 10% also in four stands. Other fairly common tree species were *Cassia abbreviata* subsp. *beareana*, *Spirostachys africana*, *Terminalia sericea, Xeroderris stuhlmannii* and the clump forming liana *Combretum mossambicense*. Typical but less common tree species were *Cleistochlamys kirkii*, *Drypetes mossambicensis*, *Guibourtia conjugata, Strychnos madagascariensis* and *S. potatorum. Combretum apiculatum* and *Guibourtia conjugata* had a cover of up to 10% in two stands.

Colophospermum mopane was in most stands dominant in the shrub layer with a maximum cover of 45% in one stand, up to 25% in six and up to 10% in seven stands. Other common tree species in the shrub layer were *Combretum apiculatum* (with a cover of 50% in one stand, up to 25% in two and up to 10% in three stands), *Dalbergia melanoxylon* (with a cover of up to 10% in one stand), *Markhamia zanzibarica, Sclerocarya birrea* subsp. *caffra*, *Strychnos madagascariensis* (with a cover of up to 10% in one stand) and *Xeroderris stuhlmannii*, and fairly common tree species were *Boscia angustifolia* var. *corymbosa*, *Cassia abbreviata* subsp. *beareana*, *Guibourtia conjugata, Lannea schweinfurthii* var. *stuhlmannii, Pteleopsis myrtifolia* and *Terminalia sericea*. Common shrubby species were *Maerua parvifolia*, *Combretum mossambicense*, *Cissus cornifolia*, *Dichrostachys cinerea* subsp. *africana*, *Euclea divinorum*, *Flueggea virosa* subsp. *virosa*, *Grewia bicolor*, *Senna petersiana* and *Tricalysia allenii*. Occasional but typical species were *Catunaregam swynnertonii*, *Coffea racemosa*, *Grewia lepidopetala, Hippocratea crenata a*nd *Tricalysia junodii*.

The herbaceous groundcover was mainly made up of grasses. *Digitaria milanjiana* and *Pogonarthria squarrosa* were the dominant grass species over a wide area. *Aristida congesta*, *A. mollissima*, *A. rhiniochloa*, *Bothriochloa radicans*, *Eragrostis cylindriflora*, *E. pallens*, *E. lehmanniana*, *Schmidtia pappophoroides* and *Urochloa mosambicensis* were locally dominant. In one stand (Stand 53) there was mainly bare ground covered in places with *Heliotropium ciliatum*. Other occasional forbs were *Barleria lancifolia*, *Dicoma tomentosa*, *Heliotropium ovalifolium*, *Hemizygia bracteosa*, *H. petrensis*, *Sida hoepfneri*, *Triumfetta pentandra* and *Waltheria indica*.

Heights of top canopy trees were 12 to 15 m in three stands, 15 to 18 m in four, and 20 to 22 m in the remainder, except for one stand where the tallest trees were estimated to be 25 m. Canopy cover was 1% or less in eleven stands, 5% in eight and 15% in three.

Trees in the second layer were in most stands between 3 and 8 m, and between 12 and 17 m in seven of them. There was considerable variation in canopy cover. It was 1 to 3% in four stands, 7% in two, 10 to 26% in eleven, 30 to 35% in three and 40 to 50% in two.

The cover of the shrub layer was 2 to 5% in seven stands, 6 to 20% in twelve, 25 to 30% in two, and 50% in one stand.

The total woody cover was 6% in one stand, 10 to 25% in three, 30 to 45% in fourteen, and 50 to70% in four.

Cover abundance of the herbaceous layer was 3 to 15% in twelve stands, 20 to 30% in five and 40 to 60% also in five.

The vegetation structure was classified as wooded grassland in four stands, open woodland in fourteen and woodland also in four.

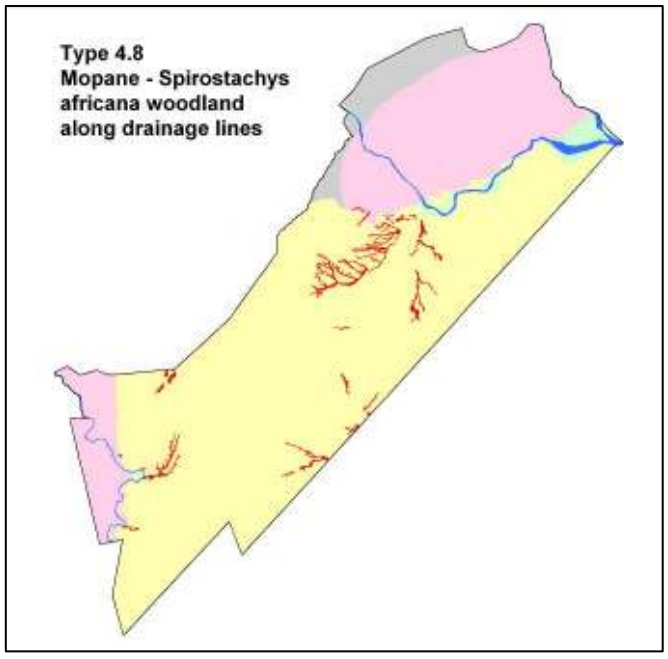
In half the stands mature canopy trees had been practically eliminated, in another eight their cover was below 5%. In three stands there was still a canopy cover of up to 15% left but most of the large trees had bark damage on the trunks. Recent elephant damage varied from moderate to severe, generally however there was extensive habitat degeneration. There was a fairly regular pattern of open spaces, up to 200 m^2 in extent, where most of the woody vegetation had been eliminated. In some areas the opening up of the vegetation had created a parkland effect, and in some stands secondary invasion mainly of *Combretum apiculatum* was taking place. In this vegetation type degeneration had created a particularly irregular vegetation pattern, again with mutilated mature trees in the lower strata, especially *Colophospermum mopane* and *Guibourtia conjugata.*

In four stands *Guibourtia conjugata* was prominent in all layers, up to a cover of 10% in the second tree layer in two of them. In three of the stands the species composition conformed well with this type and they belong to it. One stand situated on the Save-Runde junction floodplain (Stand 304) had a species composition different from all the other stands recorded in this study. However the soil was sand and since it contained, besides *Colophospermum mopane* and *Guibourtia conjugata*, a number of species that typically occur on Malvernia Beds it still fits best into this type.

Type 4.8. Mopane – *Spirostachys africana* Woodland Along Drainage Lines

6 Stands: 28, 40, 45, 54, 68, 181.

This type was recorded as numerous widely scattered strips along minor drainage lines throughout the extent of the Malvernia Beds and extending marginally onto the adjacent igneous rocks to both the south and the north (to the west of the Runde River). The overall extent was approximately 64 km^2. Six stands were investigated.



The topography was either a bottom plain or an incipient gently undulating slope. The underlying geology was Malvernia Beds. The soils were variable, comprising loamy sand, sandy loam, sandy clay loam, clay loam and loamy clay. None of the stands had any surface rock. Large termitaria occurred in three of the stands and medium sized ones in one, all at the density of 1 to 5 per hectare, and in two stands none were recorded.

The most common top canopy trees were *Colophospermum mopane* and *Spirostachys africana,* with *Spirostachys africana* mostly dominant. Other occasional canopy trees were *Acacia nigrescens, Berchemia discolor, Combretum imberbe, Diospyros mespiliformis, Philenoptera violacea* and *Strychnos potatorum*.

The most dominant tree species in the second tree layer was also *Colophospermum mopane*, it had in one stand a cover of up to 25% and in three of up to 10%. *Spirostachys africana* and *Strychnos potatorum* occurred commonly in four of the six stands, *Cassia abbreviata* subsp. *beareana* in three,

and *Combretum hereroense* var. *hereroense* and *Strychnos madagascariensis* in two. *Strychnos madagascariensis* and *S. potatorum* had a cover of up to 10% in one stand each.

In the shrub layer *Colophospermum mopane* was the most common species, in one stand it had a cover of about 8% and in another of 15%. Other tree species which were fairly common in the shrub layer were *Berchemia discolor, Boscia foetida* subsp. *rehmanniana, Cassia abbreviata* subsp. *beareana* and *Spirostachys africana*. *Combretum apiculatum, Philenoptera violacea* and *Strychnos potatorum* were somewhat less common being recorded in half of the stands. The most common shrubby species were *Dichrostachys cinerea* subsp. *africana* and *Flueggea virosa* subsp. *virosa*. Fairly common species were *Ehretia amoena, Euclea divinorum*, *E. racemosa* subsp. *schimperi*, *Grewia bicolor*, *G. caffra, G. lepidopetala* and *Senna petersiana*.

Typical woody associate species in this type were *Berchemia discolor*, *Cassia abbreviata* subsp. *beareana*, *Dichrostachys cinerea* subsp. *africana, Euclea divinorum*, *Flueggea virosa* subsp. *virosa Grewia bicolor* and *Strychnos potatorum*. In general the assemblage of this type was similar to Type 4.7. The main difference was the abundance of *Spirostachys africana* especially in the top canopy, and that *Dalbergia melanoxylon*, *Markhamia zanzibarica* and *Xeroderris stuhlmannii* were much less common.

The herbaceous groundcover was generally sparse and consisted mainly of grasses and in some places a mixture of grasses and forbs. The dominant grass species varied from stand to stand, they were *Andropogon gayanus*, *Aristida congesta*, *A. mollissima*, *Digitaria milanjiana*, *Enneapogon cenchroides*, *Eragrostis cylindriflora*, *E. lehmanniana*, *Panicum maximum* (in shade), *Pogonarthria squarrosa* and *Sorghum versicolor*.

Height of the canopy trees was 7 to 12 m in two stands, 16 to 20 m in three, and 17 to 23 m in one. Top canopy cover was less than 1% in one stand, 5% in four, and 5 to 10% in one.

Height of the trees in the second layer was 3 to7 m, where the canopy was up to 12 m, and 6 to 12 m where the canopy was up to 20 m and above. Canopy cover was 3 to 10% in two stands, 20% in three and 30 to 40% in one.

The cover of the shrub layer was from less than 1 to 2% in two stands, and 6 to 15% in four.

Total woody cover was 10 to 15% in two stands, 25 to 30% in three, and 40 to 50% in one.

Cover abundance of the herbaceous groundcover was 10 to 15% in four stands and 25% in two.

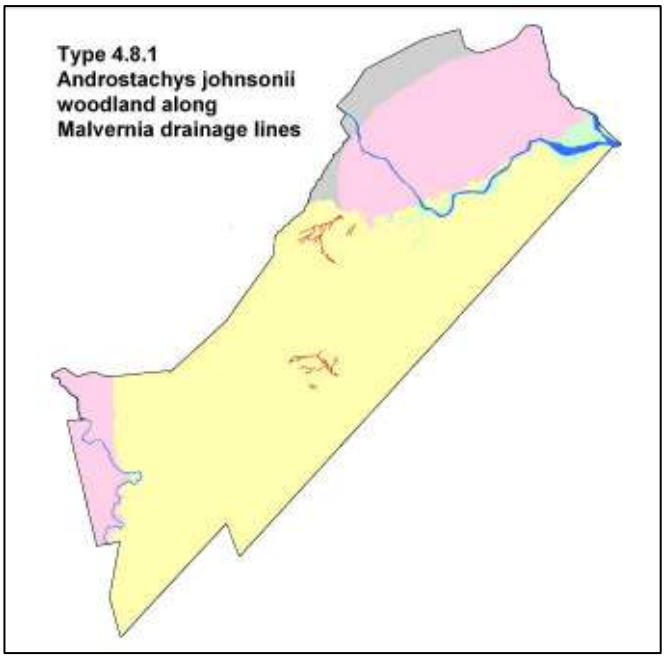
The structure of this vegetation type was wooded grassland.

Elephant and fire damage was similar to that observed for other mopane types. In one stand (Stand 45) a parkland effect was created of fairly regularly spaced large *Spirostachys africana* with grasses and patches of scrub mopane beneath.

Subtype 4.8.1. *Androstachys johnsonii* Woodland Along Drainage Lines

No Stands: (not sampled).

In some areas on the Malvernia Beds along the upper reaches of ephemeral watercourses there were dense ribbon like groves of *Androstachys johnsonii*. They seemed to occur mainly where the watercourses were deeply incised. No investigation of the species composition was made but from a distance no associate species were noted. Several sections were mapped within the Guluweni drainage in the centre of the park and, to the north, within the Lumvuma and Mutondowari drainages on either side of Nyamatongwe hill. The total extent was 9 km^2. This subtype usually merged downstream into Type 4.8 Mopane –*Spirostachys africana* woodland along drainage lines, hence its inclusion here rather than under Type 8 *Androstachys johnsonii* woodlands.



Type 4.9. Mopane Woodland on Alluvium

4 Stands: 163, 183, 305, 309.

This type was observed in the north of the park occurring sporadically along either side of the Runde River, mainly from the Benji drainage in the west to the vicinity of the Save-Runde junction in the east. There was a particularly well developed patch in the vicinity of Chipinda Pools. In some places it was found close to the rivers, but more often it occurred on the second alluvial terrace behind a belt of riparian woodland which was situated on the first levee. The portion between the Save-Runde junction was somewhat atypical, possibly due to colluvial influence. The total extent was about 29 km^2. Four stands were investigated.

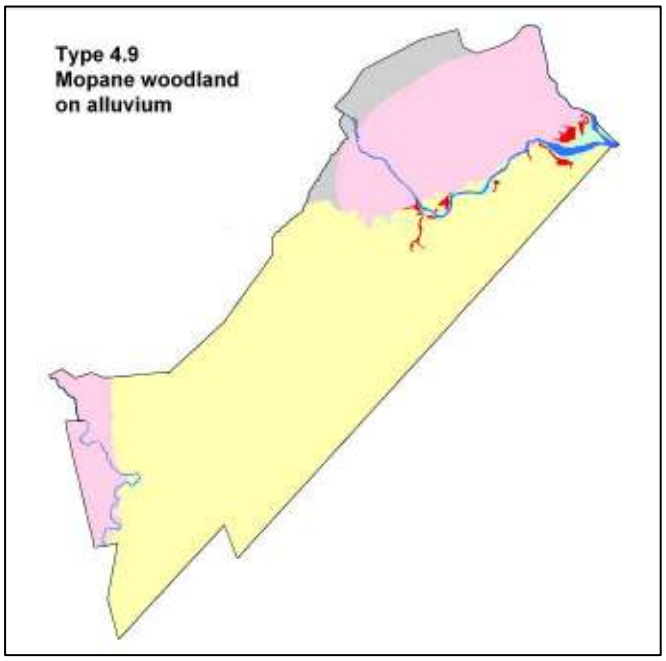
The topography was alluvial terraces and the geology alluvial deposits. The soils were dark brown clays, loamy clays or clay loams, occasionally with an olive green sheen. Medium sized termitaria were recorded for one stand at a density of 1 to 5 per ha. There was no outcropping rock.

Mopane woodland on alluvium differs from all other types by having a fairly large number of species in its assemblage that also commonly occur in riparian forest. Besides *Colophospermum mopane*, *Acacia tortilis* subsp. *heteracantha*, *Combretum imberbe*, *Diospyros mespiliformis*, *Philenoptera violacea* and *Spirostachys africana* were very occasionally recorded in the very scarce top canopy.

Associate species in the second tree layer were *Acacia nigrescens*, *A. tortilis* subsp. *heteracantha*, *Cleistochlamys kirkii*, *Combretum imberbe*, *Diospyros mespiliformis*, *Drypetes mossambicensis*, *Lannea schweinfurthii* var. *stuhlmannii*, *Markhamia zanzibarica*, *Philenoptera violacea*, *Spirostachys africana, Strychnos potatorum* and *Terminalia prunioides*.

Colophospermum mopane was also dominant in the shrub layer, in one stand it had a cover of about 30% where it consisted mainly of knocked down and resprouting mature trees. Other tree species prominent in this layer were *Cleistochlamys kirkii*, *Drypetes mossambicensis*, *Lannea schweinfurthii*

var. *stuhlmannii, Lecaniodiscus fraxinifolius* and *Terminalia prunioides*. Common shrub species were *Combretum mossambicense*, *Deinbollia xanthocarpa, Flueggea virosa* subsp. *virosa, Maerua parvifolia* and *Thilachium africanum*.



The herbaceous groundcover consisted mainly of two grass species *Aristida rhiniochloa* and *Urochloa mosambicensis*.

Tree height in the top canopy was up to 20 m occasionally up to 25 m. In some places there were still some magnificent specimens of *Colophospermum mopane* (cathedral mopane). Canopy cover was 1% or less in two stands and 7 to 10% also in two.

Tree height in the second tree layer was 4 to 10 m. Canopy cover was 1 to 5% in three stands and 20% in one. The 20% was due to mutilated canopy trees having been reduced to the second layer.

The cover of the shrub layer was 5%, 25%, 35% and 40% in one stand each. In two stands the cover was uneven due to scattered clumps of scrub mopane.

Total woody cover was 20 to 30% in two stands, and 40 to 50% also in two.

The groundcover was dense in places, bare in others, and generally uneven. Cover abundance of the herbaceous groundcover was 15% in one stand, 20% in two and 40% in one.

The structure of this vegetation type was wooded grassland and open woodland in less degraded areas.

Degradation followed a similar pattern to that described for the other mopane types, except for a few places where an effect of open parkland was still maintained.

Type 5. Mixed Woodland on Northern Igneous Rocks

Three woodland types and one subtype were recognized on the igneous rock complex which makes up the high ground in the north of the park. The most widespread one was Mixed *Brachystegia tamarindoides* Woodland (Type 5.1), a vegetation type dominated by *Brachystegia tamarindoides* subsp. *torrei*. However, its domination over a considerable portion of its distribution was an assumption since severe habitat degradation had created a void of canopy trees over large tracts of land. The underlying geology consisted of several rock types, for which one would expect more than one vegetation unit. However obvious differences, if they existed, have been obliterated by degradation. Differences might still exist but more detailed investigations beyond the scope of this study, including scrutiny of the herbaceous layer, would be required to establish this. For the present one has to accept that this vegetation type might to some extent be an artificial aggregate. One subtype was recognized (Type 5.1.1) which differed by having a significant cover of *Millettia usaramensis* subsp. *australis*, which showed up well on the satellite imagery.

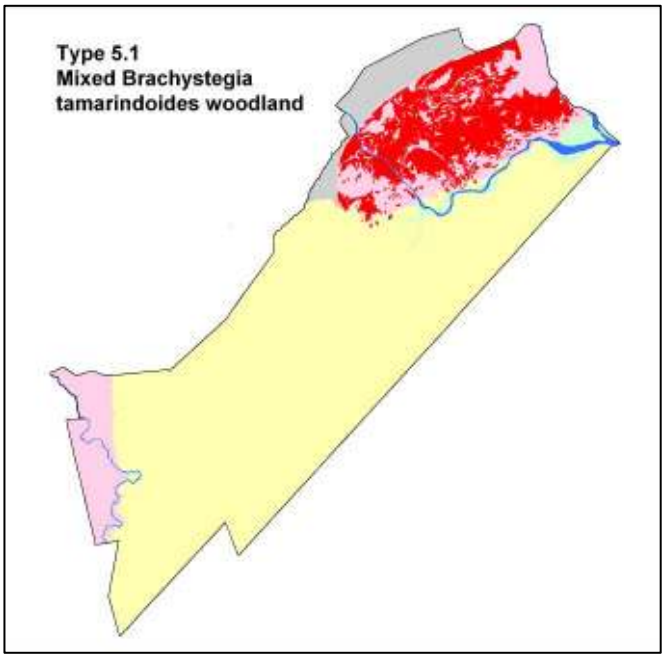
The other two vegetation types both occurred on granite. One was *Brachystegia tamarindoides* Woodland (Type 5.2), quite similar to the one discussed above. The other, Mixed Combretaceae Woodland (Type 5.3), was dominated in places by *Combretum zeyheri*, *Terminalia sericea* and *Combretum apiculatum*. This was a secondary woodland type most likely derived from a type of

miombo woodland, but there was little evidence to suggest what the original species composition could have been.

Type 5.1. Mixed *Brachystegia tamarindoides* Woodland

22 Stands: 3, 10, 16, 17, 187, 188, 190, 195, 197, 198, 199, 203, 205, 207, 211, 263, 296, 301, 308, 326, 328, 330.

This woodland type covered large expanses of the granophyritic terrain in the north of the Park, mainly north of the Runde River and to a lesser extent some of the hills to the south of it. The total extent was estimated to be 573 km^2. Twenty-two stands were investigated, ten on flatter areas and twelve on ridges and hills, including the escarpment above the basalt plain in the north.



The topography varied from extensive flat or gently undulating or slightly dipping plateau plains, to ridges, kopjes, hillsides and escarpments. The geology was granite in seven stands, syenite in six, granodiorite and granophyre each in three stands, and trachyte in two stands (no record was made for one stand). The soils were predominantly clay loam (nine stands) or sandy clay loam (2 stands), but elsewhere varied from loamy clay to loam (two stands each) to sandy loam (three stands) or loamy sand (one stand). Large termitaria were recorded in fourteen stands and medium sized ones in five. In fifteen stands the density was 1 to 5 per ha and in four stands the density was over 5 per ha. In three stands no termitaria were noted. In the hilly country outcropping rock was up to 80% or more, with rock sheets and piles of surface rock common, and soils were generally skeletal.

From field observations there seemed to be a need to subdivide this vegetation type. However, degradation obscured the differences to such an extent that attempts to subdivide were abandoned. What unites the stands into one type was mainly the presence of *Brachystegia tamarindoides* subsp. *torrei*. In a few stands it was still abundant, in most of the others its presence varied from a few scattered trees down to a few shrubby specimens or just small rudiments. In some stands it was absent and these stands were assigned to this type on the basis of associate species only.

On the flat stands with deeper soils the mature canopy trees most frequently recorded, but never in more than six of the stands, were *Adansonia digitata* (six stands), *Acacia welwitschii* subsp. *delagoensis, Kirkia acuminata* and *Xeroderris stuhlmanii* (all in four stands), and *Acacia nigrescens, Berchemia discolour, Brachystegia tamarindoides* subsp. *torrei* and *Colophospermum mopane* (all in three stands). Trees recorded in two stands were *Balanites maughamii*, *Diospyros mespiliformis*, *Drypetes mossambicensis*, *Entandrophragma caudatum*, *Kigelia africana*, *Lannea schweinfurthii* var. *stuhlmannii, Philenoptera bussei*, *Spirostachys africana*, *Strychnos madagascariensis* and *Xylia torreana*. *Brachystegia tamarindoides* subsp. *torrei* had a cover of 25% in one stand

On steep slopes and broken country with skeletal soils the most frequently recorded canopy tree species was *Kirkia acuminata* (six stands). Species that occurred in the canopy of three stands were *Adansonia digitata* and *Brachystegia tamarindoides* subsp. *torrei*. Tree species which occurred only once or twice were *Acacia nigrescens*, *Afzelia quanzensis*, *Combretum imberbe*, *Drypetes*

mossambicensis, *Gyrocarpus americanus* subsp. *africanus* and *Spirostachys africana*. *Brachystegia tamarindoides* subsp. *torrei* had a canopy cover of up to 10% in two stands.

Common tree species in both types of stands (flat and broken areas) of the second tree layer were *Boscia angustifolia* var. *corymbosa*, *Brachystegia tamarindoides* subsp. *torrei*, *Cassia abbreviata* subsp. *beareana*, *Combretum apiculatum*, *Markhamia zanzibarica* and *Xeroderris stuhlmannii*. Fairly common tree species were *Androstachys johnsonii, Diospyros loureiriana* subsp. *loureiriana*, *Drypetes mossambicensis*, *Kirkia acuminata, Philenoptera bussei, Strychnos decussata* and *S. madagascariensis.* Also common was the liana *Artabotrys brachypetalus* often forming clumps. Occasional but typical species in both types of stands were *Acacia erubescens*, *A. nigrescens*, *Vitex ferruginea* subsp. *amboniensis, V. mombassae* and *V. patula*.

Common or fairly common tree species mainly found on flattish ground in the subcanopy were *Acacia welwitschii, Berchemia discolor, Colophospermum mopane, Lannea schweinfurthii* var. *stuhlmannii*, *Philenoptera violacea* and *Pterocarpus lucens* subsp. *antunesii.* Also on flat ground the liana *Hugonia orientalis* was fairly common often forming large clumps.

On rocky hills *Combretum apiculatum* had a cover of up to 25% in one stand, and up to 10% in two. *Vitex ferruginea* subsp. *amboniensis* had a cover of 10% in three stands. *Androstachys johnsonii, Brachystegia tamarindoides* subsp. *torrei, Colophospermum mopane, Euphorbia tirucalli* and *Millettia usaramensis* subsp. *australis* all had a cover of up to 10% in one stand. *Xylia torreana* was recorded in four stands, in three of them on rocky ground and once on flat land with few rocks. It had a cover of up to 10% in one rocky stand and also in the flat stand. On flat ground *Acacia welwitschii, Brachystegia tamarindoides* subsp. *torrei, Philenoptera bussei* and *Vitex patula* all had a cover of up to 10% in one stand.

Tree species in this layer which were only recorded on rocky hillsides were *Ficus abutilifolia*, *Commiphora edulis* subsp. *edulis*, *Steganotaenia araliacea* var. *araliacea* and *Sterculia rogersii*. The first one was fairly common the other three slightly less so.

Species which commonly occurred in the shrub layer of both types of stands (flat and sloping ground) were *Alchornea laxiflora*, *Artabotrys brachypetalus*, *Boscia angustifolia* var. *corymbosa*, *Brachystegia tamarindoides* subsp. *torrei, Canthium glaucum* subsp. *frangula* var. *frangula*, *Combretum mossambicense*, *Dichrostachys cinerea* subsp. *africana*, *Hugonia orientalis*, *Markhamia zanzibarica*, *Monodora junodii* var. *junodii, Phyllanthus pinnatus* and *Xeroderris stuhlmannii*. Fairly common species in both types of stands were *Cassia abbreviata* subsp. *beareana*, *Coffea racemosa*, *Drypetes mossambicensis*, *Gardenia resiniflua* subsp. *resiniflua*, *Grewia caffra*, *Lannea schweinfurthii* var. *stuhlmannii*, *Strychnos madagascariensis*, *Thilachium africanum, Vitex ferruginea* subsp. *amboniensis* and *V. mombassae*. Typical species occasionally recorded in both types of stands were *Bauhinia tomentosa, Canthium racemulosum* var. *racemulosum*, *Cleistochlamys kirkii*, *Dalbergia melanoxylon*, *Grewia flavescens*, *Hippocratea crenata*, *Philenoptera violacea*, *Pterocarpus lucens* subsp. *antunesii* and *Tiliacora funifera*.

On rocky slopes *Androstachys johnsonii, Combretum mossambicense, Millettia usaramensis* subsp. *australis* and *Pterocarpus lucens* subsp. *antunesii* all had a cover of up to 10% in the shrub layer in one stand. On flat ground *Brachystegia tamarindoides* subsp. *torrei, Combretum mossambicense* and *Vitex ferruginea* subsp. *amboniensis* had cover of up to 10% in two stands. *Hymenocardia ulmoides, Lannea schweinfurthii* var. *stuhlmannii, Monodora junodii* var. *junodii, Philenoptera bussei, Phyllanthus pinnatus* and *Vitex mombassae* all had a cover of up to 10% in one stand.

Species in the shrub layer almost always recorded on rocky hillsides were *Adenium multiflorum*, *Anisotes rogersii* (a sub-shrub), *Commiphora edulis* subsp. *edulis*, *Cordia grandicalyx*, *Euphorbia cooperi* var. *cooperi* and *Sterculia rogersii*. Species typically found on rocky hillsides and rarely recorded on flat ground were *Afzelia quanzensis*, *Cissus cornifolia*, *Combretum padoides*,

Elephantorrhiza goetzei subsp. *goetzei*, *Etandrophragma caudatum* and *Kirkia acuminata*. Species more often found on flat land on granophyre terrain were *Acacia welwitschii* subsp. *delagoensis*, *Capparis tomentosa*, *Colophospermum mopane*, *Flueggea virosa* subsp. *virosa* and *Maerua kirkii*.

The herbaceous groundcover consisted mainly of grasses with a variable portion of forbs. Dominant grass species on steep rocky ground were *Digitaria milanjiana*, *Enneapogon cenchroides*, *Heteropogon contortus*, *Melinis repens*, *Panicum maximum* and *Urochloa mosambicensis*. Occasionally dominant grasses were *Aristida rhiniochloa, Brachiara deflexa* and *Eragrostis cylindriflora*. *Danthoniopsis dinteri* was dominant when the rock cover was high. Frequently present forbs were *Barleria spinulosa*, *Vernonia poskeana* and *Waltheria indica* and, less frequent, *Sphaeranthus peduncularis*. On flat ground the most commonly dominant grass was *Digitaria milanjiana*. Locally dominant species were *Digitaria eriantha*, *Enneapogon cenchroides*, *Eragrostis cylindriflora*, *Melinis repens*, *Perotis patens*, *Pogonarthria squarrosa* and *Urochloa mosambicensis*. Noticeable forbs were *Basananthe pedata*, *Barleria affinis*, *Hibiscus engleri*, *Melhania acuminata*, *Merremia kentrocaulos*, *Sida ovata*, *Solanum incanum*, *Tricliceras tanacetifolium*, *Vernonia poskeana* and *Waltheria indica*.

Tree height of the top canopy species was 12 to 16 m in six stands, 17 to 18 m in four, up to 20 m in eleven and 25 m in one. Canopy cover was in eleven stands below 1%, six stands had a cover of 1 to 6%, and in two it was 7 to 12%. In one stand the cover varied between 2 and 50% depending on the topography, in the rugged and rocky portions of the stand the vegetation was better protected. In most stands the large trees were widely scattered, in three stands none were recorded. In a few stands occasional fragments of the original canopy were still present.

In the second tree layer tree heights were mostly between 3 to 8 m, and up to 12 m in a few stands. Canopy cover was 1 to 5% in thirteen stands, 6 to 15% in seven, 20 to 30% in one and 40% also in one. In most of the stands the fragmentation of the second tree layer was well advanced, in some the destruction was nearing completion. The layer consisted of widely scattered young or regenerating original trees, almost all multi-stemmed from having been burned down to ground level, often after mutilation.

Generally the woody cover was higher on steeper ground than flat ground. In the most degraded stands, especially on level ground, open areas of grassland were up to 2 ha in size.

The shrub layer was generally poorly developed with less than 3% cover in seven stands, 4 to 12% in twelve, and 20 to 30% in three. Generally the shrubs were irregularly scattered or occasionally more densely grouped especially on rocks. The three stands with a cover of 20 to 30% occurred on broken land with a generally better woody cover.

Total woody cover was 5 to 15% in thirteen stands, 16 to 30% in seven, and 40 to 60% in two. The 60% refers to a rocky hill where the second tree and shrub layers still had reasonable covers.

There was considerable variation in the herbaceous groundcover. In seven stands the cover was 5 to 25%, in six 30 to 50%, in four 51 to 70% and 80 to 90% in two. In three stands no estimates were made.

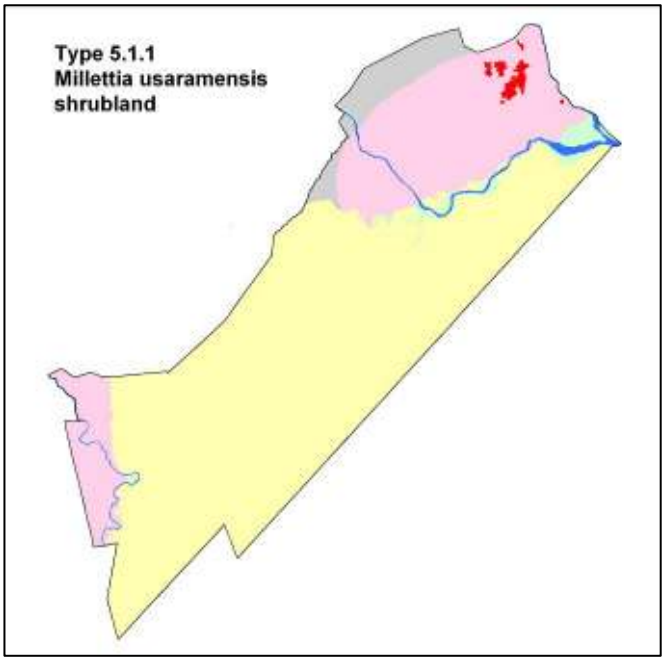
The structure varied between wooded grassland, open shrubland, open woodland and in one stand woodland.

In the highly degraded areas recent elephant damage was mainly moderate. In some of the less degraded stands, where small sections of the original canopy were still intact, degradation seemed to be in the end phase of a period of high elephant impact. Many of the living trees were mutilated, more than half of them had bark damage, and most of the damaged trees were beyond recovery. From every

point one could see at least 10 standing dead trees and 10 fallen ones. There were small areas of utter havoc surrounded by large open spaces where the destruction had been completed.

Subtype 5.1.1. *Millettia usaramensis* shrubland

2 Stands: 294, 306.



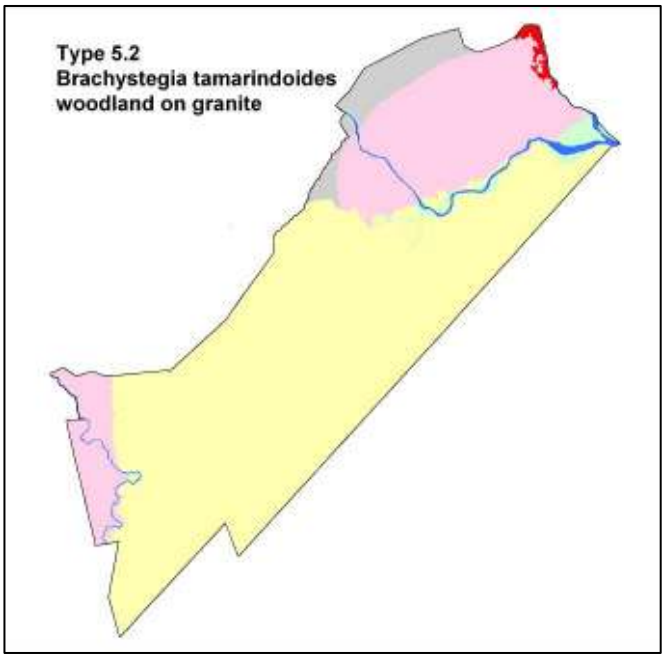
This vegetation unit consisted of six patches along the eastern portion of the granophyre complex, with a total extent of 29 km^2. Two stands were investigated.

It mainly differed from Type 5.1 by having a high cover of *Millettia usaramensis* subsp. *australis,* estimated at up to 50% in Stand 294 and up to 30% in Stand 306. The only other difference noted was that *Tiliacora funifera* was fairly common in both stands but scarce or absent in all stands of Type 5.1. There could be other differences obscured by degradation. It is also possible that the abundance of *Millettia usaramensis* subsp. *australis* was due to secondary invasion as a consequence of degradation.

Type 5.2. *Brachystegia tamarindoides* Woodland on Granite

3 Stands: 191, 192, 329.

This vegetation type occurred in the extreme northeast extending along the boundary area above the Save River valley. The total extent was 26 km^2. Three stands were investigated.



The topography consisted of rocky hills as well as flat ground interspersed with rock outcrops. The geology was granite and the soils were orange brown loamy sands or sands. Large termitaria were recorded at a density of 1 to 5 per ha in all stands.

The canopy trees were almost exclusively *Brachystegia tamarindoides* subsp. *torrei* with a cover of 50% in some places but more often between 10 and 20%. Other occasional large tree species were *Entandrophragma caudatum*, *Kirkia acuminata*, *Lannea schweinfurthii* var. *stuhlmannii*, *Xeroderris stuhlmannii* and *Xylia torreana* and, usually on flatter ground, *Adansonia digitata*, *Balanites maughamii*, *Berchemia discolor, Erythrophleum africanum* and *Pteleopsis myrtifolia*.

Most of the canopy species also occurred in the second tree layer. Other typical smaller tree species in the subcanopy were *Boscia angustifolia* var. *corymbosa*, *Cladostemon kirkii*, *Cleistanthus schlechteri, Combretum zeyheri*, *Diospyros loureiriana* subsp. *loureiriana*, *Euphorbia cooperi* var. *cooperi*, *Ficus*

abutilifolia, *Hexalobus monopetalus* var. *monopetalus, Margaritaria discoidea* subsp. *nitida*, *Markhamia zanzibarica*, *Millettia usaramensis* subsp. *australis*, *Philenoptera bussei*, *Ptaeroxylon obliquum*, *Strychnos decussata*, *S. henningsii, S. madagascariensis*, *Tabernaemontana elegans* and *Vitex mombassae*. *Androstachys johnsonii* occurred sporadically in some places.

Characteristic shrub species were *Alchornea laxiflora*, *Bridelia mollis*, *Canthium glaucum* subsp. *frangula* var. *frangula*, *C. racemulosum* var. *racemulosum*, *C. setiflorum* subsp. *setiflorum*, *Coffea racemosa, Coptosperma littorale, Euphorbia espinosa*, *Friesodielsia obovata*, *Gardenia resiniflua* subsp. *resiniflua, Hymenocardia ulmoides, Hymenodictyon parvifolium* subsp. *parvifolium*, *Maerua kirkii, Monodora junodii* var. *junodii, Phyllanthus pinnatus, Synaptolepis alternifolia, Thilachium africanum, Tiliacora funifera, Vangueria infausta* subsp. *infausta* and *Vepris bremekampii*. *Artabotrys brachypetalus*, *Combretum mossambicense* and *Hugonia orientalis*, all potential lianas, were noted in the shrub layer in places reaching the height of the subcanopy. *Millettia usaramensis* subsp. *australis*, potentially a small tree, was prominent in the shrub layer in some areas. All the species mentioned under subcanopy and some of the canopy species also featured in the shrub layer.

On the kopjes where there were pockets of soil between the rocks there was a fairly dense cover of *Danthoniopsis dinteri* and occasionally *Melinis repens*, and in some places *Barleria spinulosa* was conspicuous. On flatter areas the groundcover was mainly grass but often heavily grazed by cattle from the neighbouring settled areas. The dominant grass species was *Digitaria milanjiana* and the forbs *Waltheria indica* and an *Indigofera* species were often prominent.

Tree height in the canopy was up to 20 m. Canopy cover was 2 to 5% in the more degraded flatter areas and 30 to 50% on the kopjes.

The trees in the subcanopy were staggered in height and irregularly scattered, with heights of between 3 and 15 m and cover from 5 to 15%.

The shrub layer was sparse and irregular with a cover of 1 to 10%.

Total woody cover was 30 to 35% in two stands and 70% in one.

The herbaceous cover was 10% in one stand and 30 to 45% in the other two.

The structure varied between wooded grassland, open woodland and woodland in one stand each.

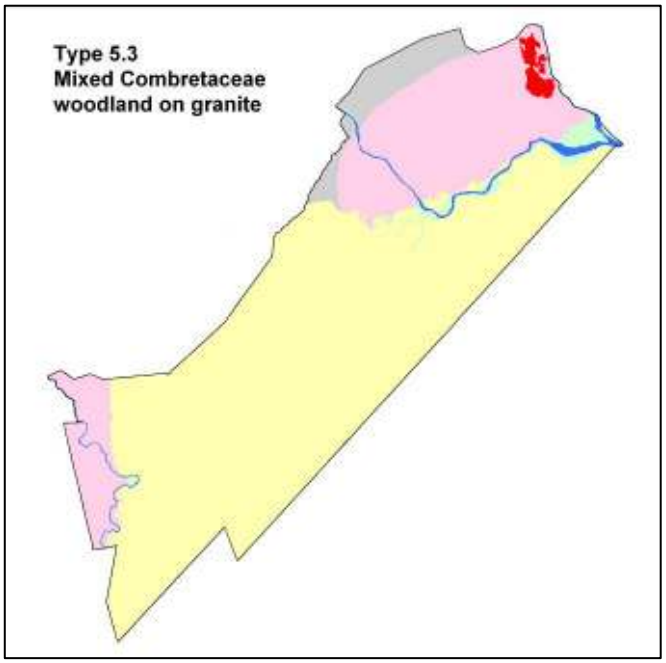
The stand which was on flat land (Stand 191) was highly degraded by people and elephants. Of the two stands situated on rocky hills the one close to the park boundary (Stand 192) had much of its timber removed by people (mainly *Brachystegia tamarindoides* subsp. *torrei* and *Androstachys johnsonii*). Stand 329 was located on a more remote kopje close to the park boundary above the Save River and exhibited some of the best preserved vegetation seen in the park.

Although the vegetation type stood out clearly on the satellite imagery, no species were identified which would clearly differentiated it from Type 5.1. Quite a number of species were recorded in one of the three stands which were never recorded in Type 5.1 but there was no species identified which occurred typically throughout the three stands and not in Type 5.1. However, there were several species which were fairly common in Type 5.1 (recorded in 36 to 64% of the stands) but were never noted in this type. These were *Acacia erubescens, A. nigrescens, Colophospermum mopane, Drypetes mossambicensis*, *Flueggea virosa* subsp. *virosa*, *Grewia caffra* and *Vitex ferruginea* subsp. *amboniensis*.

Type 5.3. Mixed Combretaceae Woodland on Granite

2 Stands: 193, 194.

This vegetation unit was a type of secondary woodland which occurred adjacent to Type 5.2 forming a single irregular shaped piece on the western side of the granite area. The total extent was 44 km^2. Two stands were investigated.



The topography was flat ground on top of an expansive ridge like plateau. There were occasional rock outcrops in some parts of the area. Soils were dark brown loamy sands to loamy clays. Large termitaria were recorded at a density of 1 to 5 per ha in both stands.

Very occasional large canopy trees were *Kirkia acuminata, Pseudolachnostylis maprouneifolia, Sclerocarya birrea* subsp. *caffra, Strychnos madagascariensis* and *Xeroderris stuhlmannii.*

The subcanopy consisted in some areas of mainly *Terminalia sericea* and in others of mainly *Combretum zeyheri* or *C. apiculatum*. Typical associate species were *Dalbergia melanoxylon, Julbernardia globiflora, Pseudolachnostylis maprouneifolia, Strychnos madagascariensis, S. spinosa, Terminalia stenostachya* and *Xeroderris stuhlmannii.* In some areas *Terminalia sericea* had a cover of up to 40 or 50%, in others *Combretum zeyheri* could have a cover of between 17 to 25%. *Terminalia stenostachya* had a cover of up to 8% in limited areas. There were occasional clumps of up to 5 m high *Julbernardia globiflora* specimens.

The shrub layer was partly made up of the tree species already mentioned. Other tree species noted in the shrub layer were *Burkea africana, Cleistochlamys kirkii, Crossopteryx febrifuga, Diospyros loureiriana* subsp. *loureiriana, Diplorhynchus condylocarpon, Millettia usaramensis* subsp. *australis, Philenoptera bussei* and *P. violacea*. Of these *Diplorhynchus condylocarpon* could have a cover of up to 10% in some places although it was never noted as a tree. Typical shrub species were *Catunaregam swynnertonii, Cissus cornifolia, Dichrostachys cinerea* subsp. *africana, Holarrhena pubescens, Ochna barbosae, Senna petersiana, Tricalysia allenii* and *Vangueria infausta* subsp. *infausta.* Of these *Dichrostachys cinerea* subsp. *africana, Holarrhena pubescens* and *Tricalysia allenii* could have a cover of up to 10% in places.

The groundcover was mainly grasses. The common species were *Digitaria milanjiana, Eragrostis cylindriflora, Heteropogon contortus, Pogonarthria squarrosa* and *Urochloa mossambicensis. Waltheria indica* was a common herb.

Tree height in the canopy was up to 18 m and the cover was less than 1%.

The height in the subcanopy was up to 10 m and the cover was 30 to 35%. In some areas the trees were closely spaced (at 5 to 10 m), in others they were much further apart and more irregularly spaced with open spaces of up to 100 m^2 in between.

The cover of the shrub layer was 7 to 10%. The shrubs were fairly evenly scattered in some places tending to be more clumped.

Total woody cover was about 40% and the herbaceous groundcover was 50 to 60%.

The structure was open woodland in some areas tending towards open shrubland.

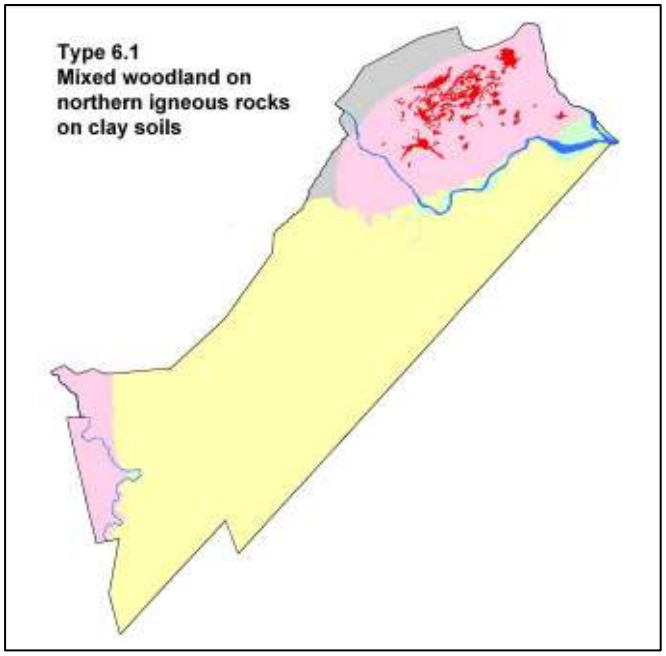
Some recent elephant damage was observed and there were occasional standing and fallen dead trees throughout. Long term fire and elephant damage was severe. There were patches where the trees were even aged, in some areas about 4 m tall in others approximately 10 m tall, and many of the young trees were multi stemmed from the base.

Type 6. Mixed Woodland on Northern Igneous Rocks on Heavier Soils

Type 6.1. Mixed Woodland on Clay Soils

5 Stands: 9, 18, 206, 293, 307.

This woodland type was only found on the granophyre complex in the north of the Park and occurred on clay soils. It was fairly extensive on the flat parts of the plateau, but also covered numerous smaller patches at the low end of the catena where the land was more undulating. It was almost always adjacent to Type 5.1 and often graded into it. The extent of this type was approximately 88 km^2. Five stands were investigated.



The topography was flat to gently undulating. The underlying rock was dolerite, granite, granodiorite or rhyolite, and the soils were mainly loamy clay, clay in one stand and sandy clay loam also in one. There were occasional rock outcrops in two stands. Large termitaria were recorded in four of the stands and medium sized ones in one, all at a density of 1 to 5 per ha.

Common top canopy trees were *Acacia nigrescens, A. welwitschii* subsp. *delagoensis, Combretum imberbe* and *Spirostachys africana.* Typical but less common trees were *Acacia galpinii, Adansonia digitata, Berchemia discolor, Crossopteryx febrifuga* and *Philenoptera violacea*.

Common species in the second tree layer were *Acacia erubescens, A. nigrescens, A. welwitschii* subsp. *delagoensis, Combretum adenogonium, C. imberbe, Crossopteryx febrifuga, Markhamia zanzibarica, Philenoptera violacea, Spirostachys africana* and *Ziziphus mucronata.* Typical but less widespread tree species were *Boscia angustifolia* var. *corymbosa, Cassia abbreviata* subsp. *beareana, Cleistochlamys kirkii, Combretum apiculatum* and *Drypetes mossambicensis.*

The most common shrub species were *Flueggea virosa* subsp. *virosa* and *Dichrostachys cinerea* subsp. *africana*. Less widespread shrubs were *Cissus cornifolia, Ehretia amoena* and *Phyllanthus pinnatus.* Typical shrubs occasionally recorded were *Allophylus rubifolius* var. *rubifolius, Grewia caffra, Monodora junodii* var. *junodii* and *Thilachium africanum.* Tree and liana species which were common in the shrub layer were *Capparis tomentosa, Cassia abbreviata* subsp. *beareana, Combretum imberbe, C. mossambicense, Drypetes mossambicensis, Markhamia zanzibarica* and *Philenoptera violacea.* Tree species fairly frequently recorded in the shrub layer were *Acacia welwitschii* subsp. *delagoensis, Boscia angustifolia* var. *corymbosa, Dalbergia melanoxylon, Diospyros mespiliformis, Lannea schweinfurthii* var. *stuhlmannii, Manilkara mochisia, Strychnos potatorum, Vitex ferruginea*

subsp. *amboniensis* and *V. mombassae.* *Combretum apiculatum* and *C. mossambicense* reached a cover of up to 10% in one stand each.

The herbaceous groundcover consisted mainly of grasses. Often dominant grass species were *Enneapogon cenchroides, Heteropogon contortus* and *Urochloa mosambicensis.* Locally dominant grasses were *Aristida meridionalis, A. rhiniochloa, Cymbopogon caesius, Digitaria milanjiana, Eragrostis cylindriflora, Panicum coloratum* var. *coloratum* and *Pogonarthria squarrosa.* Forbs were inconspicuous, occasionally observed species were *Monechma debile, Sesbania rostrata* and *Vernonia poskeana*.

Height of top canopy species was between 17 and 20 m in most stands, and up to 15 m in one. Canopy cover was from less than 1% in one stand, to 3% and 10% in one stand. The trees were widely scattered, singly or in small clumps.

Trees in the second tree layer were 3 to 5 m in height in the most degraded stand, and up to 10 m in the others. Canopy cover was up to 3% in three of the stands and up to 10% in the others. The trees were mainly multi-stemmed, many of them only 4 to 5 m tall, often in clumps or occasionally more regularly spaced, many of them young and with some regenerating mature trees. In all the stands the woody vegetation delimited large areas of grassland, in some up to 1ha in extent.

The cover of the shrub layer was 2 to 8% in five stands and 20% in one. The shrubs were often intermingled with the small trees.

There was considerable variation in the density of the herbaceous groundcover from sparse (up to 15%) in one stand, to moderately dense in three (45 to 60%) and very dense in two (80 to 90% and 90 to 95%).

Total woody cover was between 5 and 15% in four stands, and 20% and 40% in the other two.

The structure of this vegetation type was mainly wooded grassland and open woodland in a few areas.

In some of the stands recent elephant damage was noted. There were numerous standing and fallen dead trees and in many areas recent knocked down specimens of *Combretum apiculatum* were observed. Long term damage was severe, there were few large trees left and total woody cover was below 20% and in two stands below 5%. Many young trees were multi-trunked from having been reduced to ground level before resprouting. Recent fire damage was observed in some stands.

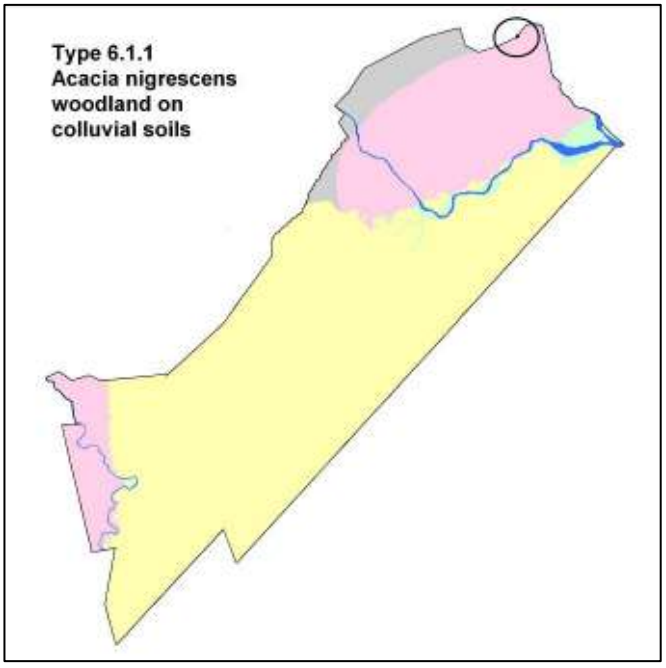
Subtype 6.1.1. *Acacia nigrescens* Woodland on Colluvial Soils

1 Stand: 196.

This vegetation subtype was only encountered on a very small area in the north of the park, at the bottom of the escarpment which separated the granophyric plateau from the basalt plain to the north of it.

The topography consisted of flattish land at the base of a slope. The underlying geology was basalt and there were fairly numerous rock fragments on the surface. The colluvial soils were dark brown loamy clays. One stand was investigated. The extent was 0.02 km^2.

Tree species recorded in the top canopy were *Acacia galpinii*, *A. robusta* subsp. *clavigera* and *Combretum imberbe*.



The same *Acacia* species were also prominent in the subcanopy, together with *Acacia erubescens*. Other common tree species in the subcanopy were *Albizia harveyi*, *Combretum hereroense* var. *hereroense*, *Dalbergia melanoxylon*, *Markhamia zanzibarica* and *Philenoptera violacea*. Less common but typical tree species were *Berchemia discolor*, *Colophospermum mopane*, *Crossopteryx febrifuga*, *Diospyros mespiliformis*, *Lannea schweinfurthii* var. *stuhlmannii* and *Ziziphus mucronata*.

Common shrub species were *Dichrostachys cinerea* subsp. *africana* and *Flueggea virosa* subsp. *virosa*, other typical shrubs were *Allophylus rubifolius* var. *rubifolius*, *Bridelia cathartica*, *Capparis tomentosa* (also a clump forming liana in the shrub layer), *Cissus cornifolia*, *Grewia subspathulata*, *Gymnosporia buxifolia* and *Senna petersiana*.

Monechma debile and Sesbania rostrata were recorded in the herbaceous layer.

Tree height in the top canopy was up to 17 m, the trees were fairly evenly scattered with a cover of about 10%.

The height of the trees in the subcanopy was staggered from 4 to 13 m and the cover was also around 10%.

There was little recent elephant damage but the woodland had been opened up probably over a prolonged period and there were areas of up to 400 m^2 devoid of trees. There was an abrupt transition into mopane woodland to the west, and in the north the woodland graded into more pure *Acacia* woodland.

Type 7. *Combretum apiculatum* Woodland on Igneous Rocks

Vegetation types dominated by *Combretum apiculatum* were found on basalt and granophyre in the north of the Park, on the igneous rock complex in the southwest and widely scattered over the Malvernia Beds. The ones that occurred on Malvernia Beds are excluded here since they could be recognized as a degraded form of *Guibourtia* woodland (Type 1.2).

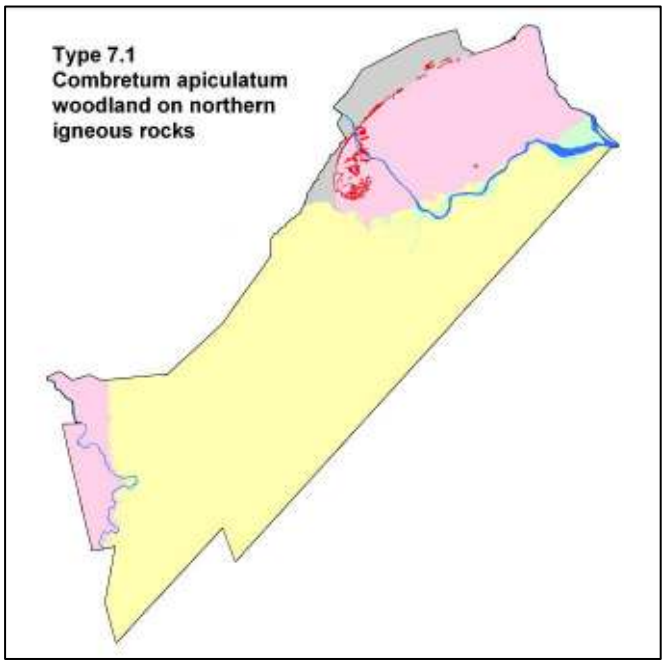
Apart from the shared dominance of *Combretum apiculatum*, the 14 samples of this general vegetation type were extremely heterogeneous. Different sets of species were shared between each of the sampled stands and the shared portion was never more than half and sometime lower than one fifth of the overall species. Also many species only occurred in one to three stands, which rendered the set of associate species in each stand somewhat unique. Furthermore differences in geology were not reflected in species distributions. However the general species assemblage differed somewhat between the north and southwest, and some species although they only occurred in a few stands were confined to either the north or the southwest. Hence this vegetation type was divided into two types in accordance with geography.

It could be that much of the *Combretum apiculatum* woodland discussed here was secondary and represented, in many areas, extremely degraded *Colophospermum mopane* woodland invaded by *Combretum apiculatum*.

Type 7.1. *Combretum apiculatum* Woodland on Northern Igneous Rocks

9 Stands: 1, 14, 139, 140, 141, 143, 189, 208, 264.

This vegetation type was found in the north of the Park mainly as numerous small scattered patches along the northern rim of the granophyre plateau, extending south on to the plateau in the vicinity of and particularly to the west of the Runde River, with additional small areas on the adjacent basalts. The total extent was 29 km^2. Nine stands were investigated.



The topography consisted of moderately to fairly steep hill slopes and occasionally ridge tops, with outcropping and loose surface rock covering 30 to 80% of the ground. The geology was basalt in four stands, granodiorite in two, and granite, granophyre and syenite each in one stand. The soils predominantly ranged from clay to loamy clay to clay loam (in seven stands), and to sandy loam and loamy sand each in one stand. Large termitaria were recorded in two stands at a density of 1 to 5 per ha. In the remaining seven stands no termitaria were observed.

The most widely recorded top canopy tree was *Kirkia acuminata*. *Colophospermum mopane* was noted in four and *Adansonia digitata* in three stands.

The second tree layer was mainly composed of *Combretum apiculatum* with a cover of 15 to 60% (25 to 35% in most stands). The most common associate species was *Colophospermum mopane*. Other fairly common but less widespread species were *Acacia nigrescens*, *Boscia angustifolia* var. *corymbosa*, *Cassia abbreviata* subsp. *beareana, Drypetes mossambicensis, Lannea schweinfurthii* var. *stuhlmannii, Markhamia zanzibarica* and *Vitex ferruginea* subsp. *amboniensis*.

The most common shrub species were *Cissus cornifolia*, *Combretum mossambicense* and *Rhoicissus revoilii*. Fairly common but more localized shrubs were *Canthium glaucum* subsp. *frangula* var. *frangula*, *Dichrostachys cinerea* subsp. *africana*, *Ehretia amoena, Elephantorrhiza goetzei* subsp. *goetzei, Gardenia resiniflua* subsp. *resiniflua, Grewia caffra*, *Hippocratea buchananii* and *Phyllanthus pinnatus*. However shrubby forms of *Combretum apiculatum* dominated the shrub layer, with a cover of 40% in one stand and 10 to 20% in several others, indicating the invasive nature of this species. Other tree species which were fairly prominent as shrubs were *Acacia nigrescens, Colophospermum mopane*, *Markhamia zanzibarica*, *Philenoptera violacea*, *Strychnos madagascariensis, Vitex ferruginea* subsp. *amboniensis* and *Xeroderris stuhlmannii*.

The herbaceous groundcover consisted mainly of grasses. Dominant on the steeper slopes were *Aristida rhiniochloa, Enneapogon cenchroides* and *Melinis repens*. Common on flatter ground were *Heteropogon contortus* and *Schmidtia pappophoroides*. Other common and locally dominant grass species were *Digitaria milanjiana*, *Eragrostis superba*, *Pogonarthria squarrosa* and *Urochloa mosambicensis*.

Height of the top canopy trees was 16 to 20 m in some stands, 20 to 22 m in others and up to 25 m in one. Canopy cover was below 1% in six stands and 1 to 3% in the other three. There were no canopy trees in one stand, hardly any in two others, and in the rest they were widely scattered.

The second tree layer was generally better wooded. Cover varied from 15 to 25% in four stands, to 40 to 60% in five. Tree height was mainly from 4 to 8 m, sometimes merging with the shrub layer, and up to 12 m in one stand. Trees were evenly distributed in some stands and more irregularly clumped in others. Open spaces varied in size from up to 100 m^2 in the better wooded stands to between 400 m^2 to one ha in the opened up ones. In some stands the canopy cover decreased up the slope. Often the variety of species increased in the vicinity of rock outcrops. Even aged stands of *Combretum apiculatum* were noticeable in many places which indicated relatively recent invasion.

The shrub layer had a cover of 1 to 7% in seven of the stands, and 12% and 30% in the other two. The shrubs were irregularly aggregated and occurred mainly in rocky areas.

Total woody cover was 15% in one stand, 30 to 35% in three, 50 to 60% in four, and 60 to 70% in the best wooded one.

Cover abundance of the herbaceous groundcover was 15 to 20% in four stands, 30 to 50% in another four and 70% in one.

The structure of this vegetation type was wooded grassland in one stand, open woodland in three and woodland in the remainder.

Over most of this vegetation type the impression gained was that *Combretum apiculatum* and a few other species were invading highly degraded *Colophospermum mopane* woodland, or a mixed woodland in which *C. mopane* was prominent. However, on a small inselberg within mopane woodland *Colophospermum mopane* was only found at the lowest end of the slope and ceased to occur within a few metres upwards, suggesting that the vegetation above (*Combretum apiculatum* woodland) was the original one.

Recent damage by elephant was moderate consisting of mutilated trees, removal of bark and pushed over trees. However, long term degradation was enormous and had caused changes in the entire habitat. The original vegetation had been almost totally obliterated and, in more recent years, the secondary woodland cover was decimated by 40 to 85%.

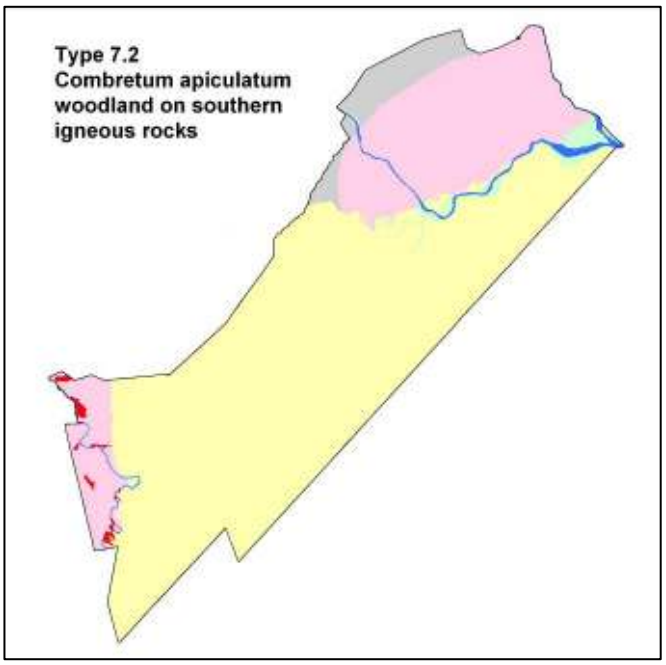
Type 7.2. *Combretum apiculatum* Woodland on Southern Igneous Rocks

5 Stands: 36, 65, 84, 214, 217.

This type of *Combretum apiculatum* woodland covered some of the land on the belt of gentle hills which occurred along the western boundary to the southwest of the Park. Its total extent was 18 km^2. Five stands were investigated.

The topography comprised flat to gentle undulating land on upland ridges and hill slopes with a gradient of up to about 10%. The underlying geology was rhyolite in two stands and granite, granodiorite and syenite in one each. The soils were loamy sand in two stands, to sandy loam, sandy clay loam and clay loam each in one stand. Large termitaria and medium sized ones were noted in two stands each, all at a density of 1 to 5 per ha. In one stand no termitaria were recorded. There were few to numerous rock outcrops in all but one stand.

This vegetation type was almost devoid of top canopy trees. Occasional large specimens of *Acacia nigrescens* were recorded in two stands and mature specimens of the following species were recorded in one stand only: *Adansonia digitata*, *Berchemia discolor*, *Combretum imberbe*, *Kirkia acuminata* and *Lannea schweinfurthii* var. *stuhlmannii*.



In all the stands the dominant tree species in the second layer was *Combretum apiculatum* and its cover ranged from 10 to 25%. The most common associate species in this layer were *Colophospermum mopane, Combretum hereroense* var. *hereroense, C. mossambicense* (a liana) and *Markhamia zanzibarica*. Other more localized but fairly common tree species were *Acacia erubescens*, *A. nigrescens*, *Cassia abbreviata* subsp. *beareana*, *Combretum imberbe*, *Lannea schweinfurthii* var. *stuhlmannii*, *Peltophorum africanum* and *Spirostachys africana*. Less common but typical tree species were *Guibourtia conjugata*, *Strychnos decussata* and *Xeroderris stuhlmannii*. In a few places *Androstachys johnsonii* was noted.

The most common shrub species were *Canthium glaucum* subsp. *frangula* var. *frangula* and *Dichrostachys cinerea* subsp. *africana*. Other common shrubs were *Flueggea virosa* subsp. *virosa, Grewia caffra* and *Tricalysia allenii,* and fairly common ones were *Euclea divinorum*, *Grewia bicolor*, *Phyllanthus pinnatus* and *Rhigozum zambesiacum*. Tree species important in the shrub layer were *Combretum apiculatum*, in some places with a cover of up to 20%, and *Colophospermum mopane* which was always prominently present with a cover of up to 10% in one stand. Other tree species which contributed significantly to the shrub cover were *Acacia erubescens*, *Boscia angustifolia* var. *corymbosa*, *Cassia abbreviata* subsp. *beareana*, *Combretum hereroense* var. *hereroense, C. mossambicense* (a liana but often only a shrub), *Strychnos madagascariensis* and, to a lesser extent, *Androstachys johnsonii, Guibourtia conjugata, Markhamia zanzibarica, Peltophorum africanum* and *Xeroderris stuhlmannii*.

The ground cover was in many areas made up of grasses. The dominant species were *Aristida adscensionis, Digitaria milanjiana*, *Melinis repens, Pogonarthria squarrosa* and *Urochloa mosambicensis*. *Aristida congesta, Eragrostis curvula*, *E. lappula*, *E. lehmanniana* and *E. superba* were in places locally common. In some of the open areas forbs were quite prolific. Species noted were *Celosia trigyna*, *Dicoma tomentosa*, *Vernonia poskeana* and *Waltheria indica*.

Top canopy trees were widely scattered sometimes reduced to a few isolated trees, and in three stands totally absent. Their cover was below 1% and their height 18 to 20 m.

The height of the second tree layer was generally low, from 3 to 7 m, in some areas merging with the shrub layer. The tree cover was as low as 5% in one stand, and between 10 to 20% in four.

In some areas trees were fairly evenly distributed, 5 to 10 m apart with frequent open spaces of up to 100 m^2 in between. In others the trees were more irregularly spaced, clumped or in lax groups, interspersed with large open spaces of up to one ha in extent. As one went up a slope open areas often increased in size. Most trees were young specimens and almost always multi-trunked from having been burnt to ground level during veld fires.

The cover of the shrub layer was generally low, 1 to 2% in two stands and 10 to 15% in three.

Total woody cover was from 15 to 20% in three stands and 21 to 35% in two.

The herbaceous cover was 5% in one stand, 15 to 20% also in one, 30 to 40% in two, and 40 to 50% in one stand.

The structure of the vegetation could be described as wooded grassland, open woodland, woodland, grassland shrubland mosaic, open shrubland or shrubland, depending on the height of the trees and the density of the cover.

Observed elephant damage was moderate in some stands and quite severe in others. In the heavily damaged areas numerous flattened small trees could be seen. Up to six standing dead trees and 16 fallen ones were counted from one point. Two stands showed open patches with numerous dead *Androstachys johnsonii* trees. Few live *Androstachys johnsonii* were recorded indicating that they could have been more common in some places.

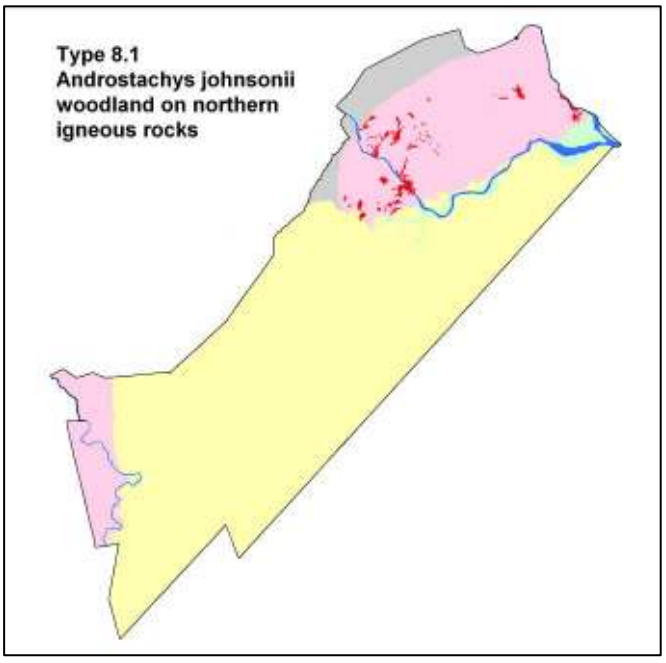
Type 8. *Androstachys johnsonii* Woodland on Igneous Rocks and Malvernia Beds

Androstachys johnsonii woodland was found on the northern granophyre complex, the Malvernia Beds and the igneous complex in the south. *Androstachys johnsonii* was the dominant woody component throughout, but the composition of the associated species was different in each of the areas such that four types could be clearly recognized. However, there was considerable variation of associated species between the stands within a type, and no associates were recorded which were confined to a type and occurred in all the stands. This made it impossible to characterize the types by one to three associate species that occurred throughout, and name them accordingly. Thus the types could only be characterized by describing them more fully, and since they could be easily recognized by locality they were named in accordance with occurrence.

Type 8.1. *Androstachys johnsonii* Woodland on Northern Igneous Rocks

7 Stands: 8, 15, 184, 201, 210, 262, 267.

This woodland type was found as numerous small scattered patches across the northern granophyre complex, particularly in the vicinity of the Runde River but with occasional patches extending east as far as the Save River. Seven stands were investigated. The total extent was 32 km^2.



The topography was hill tops, gentle to steep hill slopes and flat to undulating tops of ridges. The geology to the north of the Runde River was mainly granodiorite and in one stand each granite and granophyre, and to the south close to the Runde it was syenite and at Benji Weir rhyolite. There was much outcropping rock in most stands. The soils were variously brown clay loam, loam, sandy clay loam, sandy loam or loamy sand. In five stands large termitaria were recorded at a density of 1 to 5 per ha, in two stands there were none.

Mature top canopy trees were mainly widely scattered clumps of *Androstachys johnsonii*. Widespread but never common associated tree species were *Entandrophragma caudatum* and *Kirkia acuminata* and, at a lower level, *Cassia abbreviata* subsp. *beareana* and *Combretum apiculatum*. Occasional but characteristic species were *Brachystegia tamarindoides* subsp. *torrei*, *Gyrocarpus americanus* subsp. *africanus* and *Xeroderris stuhlmannii*.

In the second tree layer the dominance of *Androstachys johnsonii* was even more pronounced. Widespread and sometimes common associate species were, in order of approximate importance,

Combretum apiculatum, *Cassia abbreviata* subsp. *beareana*, *Xeroderris stuhlmannii*, *Markhamia zanzibarica*, *Boscia angustifolia* var. *corymbosa* and *Acacia erubescens*. Other typical but more localized tree species were *Brachystegia tamarindoides* subsp. *torrei*, *Lannea schweinfurthii* var. *stuhlmannii*, *Sterculia rogersii* and *Cleistochlamys kirkii*. *Androstachys johnsonii* had a cover of 40 to 50% in one stand and *Combretum apiculatum* up to 10% also in one stand.

Androstachys johnsonii was the most prominent species in the shrub layer, in some stands attaining a cover of up to 30%. Other tree species common in the shrub layer were *Acacia erubescens*, *Boscia angustifolia* var. *corymbosa*, *Brachystegia tamarindoides* subsp. *torrei*, *Cassia abbreviata* subsp. *beareana*, *Combretum apiculatum*, *Lannea schweinfurthii* var. *stuhlmannii*, *Markhamia zanzibarica, Vitex ferruginea* subsp. *amboniensis* and *Xeroderris stuhlmannii*. Common shrub species were *Canthium glaucum* subsp. *frangula* var. *frangula*, *C. setiflorum* subsp. *setiflorum*, *Dichrostachys cinerea* subsp. *africana*, *Gardenia resiniflua* subsp. *resiniflua*, *Monodora junodii* var. *junodii* and *Phyllanthus pinnatus* plus *Artabotrys brachypetalus, Combretum mossambicense* and *Strophanthus kombe*. The latter three can also be lianas.

In degraded open patches the herbaceous groundcover consisted mainly of grasses with forbs barely visible. In places with surface rock forbs were much more common. The most common grass species was *Enneapogon cenchroides*. Other common grass species were *Aristida scabrivalvis*, *Digitaria milanjiana*, *Melinis repens*, *Sorghum halepense* and *Urochloa mosambicensis*. Notable forbs were *Bulbostylis burchellii*, *Celosia trigyna*, *Hibiscus caesius* subsp. *caesius*, *H. micranthus*, *Merremia pinnata* and *Vernonia poskeana*.

The height of the large trees was up to 12 m in one stand and between 15 to 16 m in most others. In two stands the height was between 18 to 22 m, which referred to emergent trees such as *Kirkia acuminata* and *Entandrophragma caudatum*. Mature *Androstachys johnsonii* were between 12 to 16 m in height.

The cover of emergent mature trees was 1% or less. In all stands they were widely scattered or totally absent over expansive areas. There were numerous open spaces with grassland. In many of them there were scattered standing dead trees, all *Androstachys johnsonii*.

The height of the second tree layer was 4 to 8 m in most of the stands and up to 12 m in two of them. The mature *Androstachys johnsonii* specimens were essentially in this layer. Cover abundance in this layer was 1% in one stand, 5 to 10% in two others and 20 to 40% in the remainder. There were patches which consisted of dense even aged groves of *Androstachys johnsonii* only, with bare ground underneath. There were other much more open patches which contained a mixed array of woody species, staggered in height and haphazardly scattered, grouped or clumped, comprising either young trees or mutilated and regenerating older ones.

The shrub layer had a cover abundance of 1% in one stand and 6 to 15% in the others. The main bulk of this layer was made up of about 20 species, partly shrubs and partly young trees. The layer was widely scattered or variously grouped but did not enter the stands of *Androstachys johnsonii*.

The total woody cover was 5 to 12% in 3 stands, 15 to 20% in one, and 25 to 45% in the remaining three. The higher cover values relate to large groves of *Androstachys johnsonii*.

The herbaceous cover varied from 5 to 40%. The low values relate to a high cover of surface rock or to a lesser extent to a high value of woody cover.

This naturally heterogeneous vegetation type has been rendered even more fragmented by degradation. To sum up its physiognomy was made up of widely scattered mature emergent trees, dense stands of *Androstachys johnsonii*, grassland with standing dead *Androstachys johnsonii* trees and open spaces

with mainly grassland, grading into areas with 10 to 15 species of loosely scattered either young or regenerating old trees. All these units were variable in size and shape.

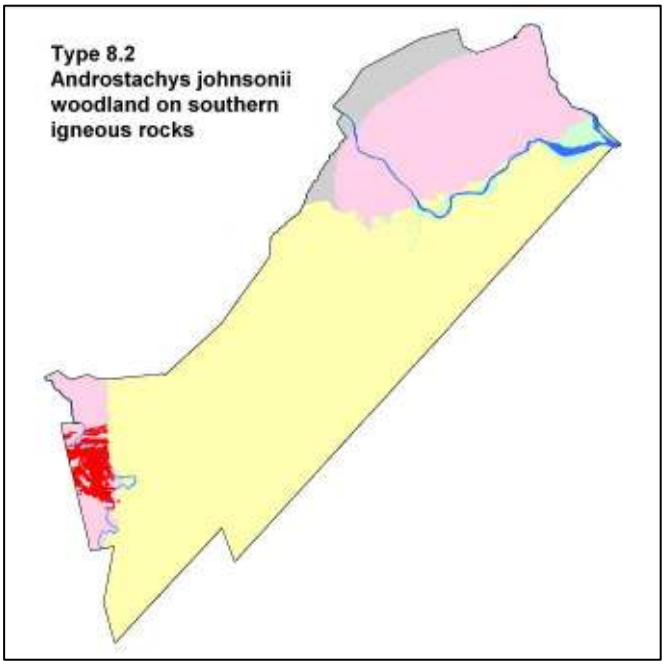
The vegetation structure varied between wooded grassland, open woodland and woodland.

Elephant damage was visible in all stands. There were numerous broken down or pushed over *Androstachys johnsonii* trees. Most mature trees had bark damage. Misshapen *Brachystegia tamarindoides* subsp. *torrei* showed evidence of repeated mutilation over several years. However the most serious recent damage to *Androstachys johnsonii* was caused by fire. In some areas *Androstachys johnsonii* looked to be threatened by total elimination. However *Androstachys johnsonii* was plentiful in the shrub layer and numerous seedlings were observed in many places.

Type 8.2. *Androstachys johnsonii* Woodland on Southern Igneous Rocks

6 Stands: 22, 24, 37, 86, 87, 213.

This vegetation type occurred in the extreme southwest of the Park on the hilly belt of igneous rock formations. Six stands were investigated. The total extent was 81 km^2.



The topography was flat ground on upland plains (two stands) or gentle to moderately steep slopes on hillsides (four stands). The underlying geology was mainly rhyolite (four stands) with one stand on granite and one on granodiorite. The soils consisted of loams, sandy loams and loamy sands, variously brown in colour and occasionally with pebbles. There were occasional to numerous rock outcrops in all stands. In two stands each there were medium sized termitaria recorded at a density of 1 to 5 per ha, large ones at the same density, or large ones at a density of more than five per ha.

The large mature trees varied in height and there was no continuous canopy. The most common tree was *Androstachys johnsonii* although few of the mature trees of this species reached to the top layer. It had a cover of up to 10% in one stand. Other common or fairly common mature large species were *Cassia abbreviata* subsp. *beareana* and *Kirkia acuminata*. Occasionally recorded but typical species were *Acacia nigrescens, Afzelia quanzensis*, *Berchemia discolor*, *Colophospermum mopane, Diospyros mespiliformis*, *Pseudolachnostylis maprouneifolia* and *Xeroderris stuhlmannii*.

In the second tree layer *Androstachys johnsonii* was by far the most common species with a cover of 10% in two stands and 25%, 40% and 70% in one stand each. Other widespread and common or fairly common species were, in order of importance, *Combretum apiculatum*, *Boscia angustifolia* var. *corymbosa*, *Combretum hereroense* var. *hereroense*, *Acacia erubescens, Lannea schweinfurthii* var. *stuhlmannii*, *Crossopteryx febrifuga* and *Diospyros mespiliformis.*

The most common shrub species were *Croton pseudopulchellus*, *Phyllanthus pinnatus* and *Diospyros lycioides*. *Croton pseudopulchellus* was often growing close to *Androstachys johnsonii* and was the only species that grew commonly beneath them. *Diospyros lycioides* was typical of this type and confined to it. Other species common in the shrub layer were *Flueggea virosa* subsp. *virosa*, *Dichrostachys cinerea* subsp. *africana*, *Canthium glaucum* subsp. *frangula* var. *frangula* and *Capparis tomentosa* (a potential liana). Shrubs which occurred in half of the stands were *Combretum*

mossambicense, C. padoides, Euclea divinorum Grewia caffra and *Tricalysia allenii.* Of the tree species, young *Androstachys johnsonii* specimens were an important and sometimes dominant component of the shrub layer, in two stands it had an estimated cover of up to 10%. Other tree species common or fairly common in the shrub layer were *Cassia abbreviata* subsp. *beareana, Combretum apiculatum, C. hereroense* var. *hereroense*, *Margaritaria discoidea* subsp. *nitida, Strychnos decussata, Vitex mombassae* and *Xeroderris stuhlmannii*.

The ground beneath *Androstachys johnsonii* was mainly bare and the herbaceous ground cover was confined to open spaces. It consisted in some areas almost exclusively of grasses, in others of more or less equal proportions of grasses and forbs. Common grass species were *Aristida adscensionis*, *Digitaria milanjiana*, *Eragrostis viscosa*, *Melinis repens*, *Perotis patens*, *Pogonarthria squarrosa* and *Sporobolus panicoides*. *Chloris virgata* was locally common and occurred in patches. The species of forbs recorded were *Ammannia prieuriana*, *Dicoma tomentosa*, *Hibiscus micranthus*, *H. seineri*, *Schoenoplectus senegalensis*, *Tephrosia noctiflora*, *Tragia okanyua* and *Vernonia poskeana*.

The heights of the mature trees in the top canopy were 14 to 20 m, the lower heights referring to *Androstachys johnsonii* and the greater height to emergent trees. Tree cover was below 1% or less in five stands and about 10% in one. Associate trees were widely scattered and *Androstachys johnsonii* occurred in patches.

The height of the second tree layer was up to 4 m in one stand, 4 to 5 m in another and 4 to 9 m in the rest of them. Canopy cover was 5 to 15% in four of the stands, 25 to 30% in one and 50 to 60% also in one. *Androstachys johnsonii* occurred in large groves in the better wooded stands or in small scattered fragments in the more degraded ones. Associate species were irregularly distributed, some were emerging from *Androstachys johnsonii* groves others grew in open spaces.

There were open spaces throughout, many containing dead standing trees. The spaces varied in size, up to 2,000 m^2 or more in the highly degraded stands but much smaller in the better wooded ones.

The cover of the shrub layer was 1 to 5% in 3 stands and 6 to 8% in the others. Generally shrubs were irregularly scattered in the open spaces. In some areas there were fairly even stands of young shrubby *Androstachys johnsonii* plants. Seedlings of *Androstachys johnsonii* were plentiful occurring in patches throughout.

The cover abundance of the herbaceous groundcover was 3 to 5% in three stands, 15 to 25% in two and 35 to 40% in one.

Total woody cover was 8 to 20% in 4 stands, 30 to 35% in one and 60% also in one.

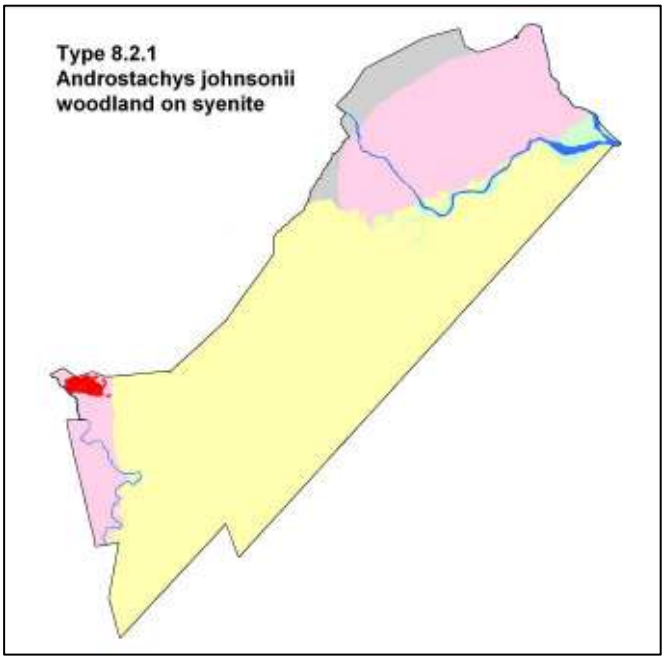
The vegetation structure was wooded grassland in four stands, open woodland in one and woodland also in one.

There were numerous stumps of *Androstachys johnsonii* showing evidence that they were cut down with an axe, indicating that people come into the park to cut and remove wood.

There was some recent elephant damage but most of the habitat degradation had occurred over a prolonged period. Canopy cover was below 1% in all except one stand where it was up to 10%. In some areas there were still sizeable groves of mainly young and medium aged trees, but over most of the area habitat degradation was severe. There were numerous open areas up to almost one ha in extent containing many standing and fallen dead trees, in some places there were too many to count.

Subtype 8.2.1 *Androstachys johnsonii* Woodland on Syenite

2 Stands: 35, 219.



Two stands of *Androstachys johnsonii* woodland on southern igneous rocks occurred on syenite rather than rhyolite. Both were situated the extreme northwest corner of the southern part of the park. One was on the top of a rocky ridge and the other on flat ground interspersed with rock outcrops. The total extent was 25 km^2.

The two stands shared 61 to 70% (14 and 17 species) of their species with half to all the stands of Type 8.2 (*Androstachys johnsonii* woodland on southern igneous rocks), but four of the typical species of Type 8.2 were absent. These were *Acacia erubescens*, *Canthium glaucum* subsp. *frangula* var. *frangula*, *Crossopteryx febrifuga* and *Diospyros mespiliformis*.

Both stands contain *Wrightia natalensis,* a rare tree which was only recorded in three other stands during the field work. Apart from this each stand contained four or six species which they did not share with each other or with any stand in Type 8.2.

Type 8.3. *Androstachys johnsonii* Woodland on Malvernia Sands

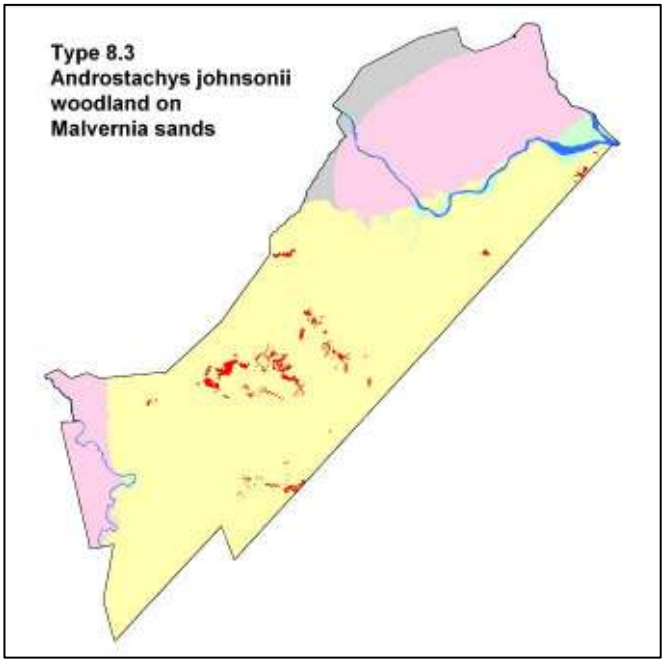
5 Stands: 105, 238, 276, 311, 322.

Numerous relatively small lenses of this vegetation type occurred, irregularly scattered, over the entire extents of the Malvernia sands. Five stands were investigated distributed over most parts of the beds. The total extent was 46 km^2.

The topography consisted of level ground, undulating in places, or gentle slopes. The geology was Malvernia Beds, sandstone was identified in two stands in which there were very occasional surface rocks. The soils were surprisingly variable, sand in two stands, and sandy loam, loam and clay loam in the other three. Large termitaria were recorded in three stands, and medium and small ones in one stand each, all at a density of 1 to 5 per ha.

The widely scattered mature emergent trees in the top canopy were mainly *Guibourtia conjugata.* Occasional other emergent trees were *Acacia welwitschii* subsp. *delagoensis*, *Brachystegia tamarindoides* subsp. *torrei*, *Colophospermum mopane*, *Entandrophragma caudatum*, *Newtonia hildebrandtii* var. *pubescens*, *Ptaeroxylon obliquum* and *Wrightia natalensis*. At a lower level there were in some stands mature clumps of *Androstachys johnsonii,* with a cover abundance of up to 10% in two stands.

The second tree layer consisted mainly of *Androstachys johnsonii* which had a cover of 10% in one stand, 40 to 75% in three and 80% in one. A common and widespread associate species was *Guibourtia conjugata* with a cover of up to 10% in one stand. Other fairly common tree species were *Cassia abbreviata* subsp. *beareana*, *Philenoptera bussei*, *Pterocarpus lucens* subsp. *antunesii, Vitex mombassae* and *Xeroderris stuhlmannii*.



Androstachys johnsonii was also the most common species in the shrub layer with a cover of 10% and 25% in one stand each. Other common tree species in the shrub layer were *Cassia abbreviata* subsp. *beareana* and *Guibourtia conjugata.* The most commonly occurring shrub was *Croton pseudopulchellus* which had a cover of about 10% in three stands. Other common shrubby species were *Combretum celastroides* subsp. *celastroides*, *Senna petersiana* and *Thilachium africanum*.

Common grass species in the herbaceous groundcover were *Digitaria milanjiana*, *Enteropogon macrostachyus*, *Panicum maximum*, *Pogonarthria squarrosa* and *Schmidtia pappophoroides*. In some areas forbs made up a significant proportion of the ground cover. Forbs recorded were *Vernonia fastigiata* and *Waltheria indica*.

Tree height of the mature emergent trees was up to 20 m. Mature trees in the *Androstachys johnsonii* canopy were 12 to 15 m tall. The cover of mature trees, exempting *Androstachys johnsonii*, was 1% or less in two stands and 5 to 9% in the other three. Mature *Androstachys johnsonii* specimens attained a cover of up to 10% in two of the stands. Some of the tree species, especially *Acacia welwitschii* subsp. *delagoensis*, *Brachystegia tamarindoides* subsp. *torrei*, and *Guibourtia conjugata,* occurred as emergents within the *Androstachys johnsonii*, others were found in relatively small open spaces adjacent to *Androstachys johnsonii*. Similar to Type 8.1, open spaces with standing dead *Androstachys johnsonii* occurred throughout.

The height of the second tree layer was up to 12 m in most stands, but with some portions of the canopy often considerably lower. In one stand the height was only 3 to 5 m. In the most degraded stand the cover was estimated at 11%, in three stands from 30 to 55%, and 80% in the best preserved one. *Androstachys johnsonii* occurred in close stands with individual trees only 2 to 5 m apart. In the more degraded stands the groves were fragmented into small patches. Associated tree species occurred, except for a few of them, in open spaces.

The cover of the shrub layer was extremely variable depending on the state of degradation. It varied from less than 1% to 5% in three stands, 13% in one and 30% also in one.

Total woody cover was 20 to 30% in one stand, 50 to 60% in two and 80% also in two.

In the *Androstachys johnsonii* groves there was mainly bare ground. In the open areas the herbaceous groundcover was less than 1% to 5% in four stands and 40 to 60% in the remaining one.

The structure of the vegetation varied from a grassland/shrubland mosaic in the most degraded areas, to shrubland, open woodland and woodland in the better preserved places.

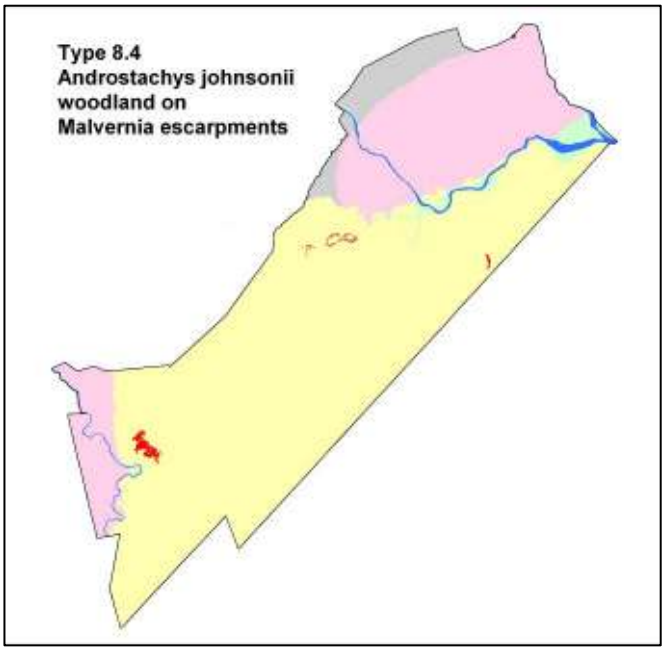
Observed elephant damage was fairly severe in most stands. Numerous pushed over and standing mutilated trees were noted. In one area up to 15 fallen trees were counted from one point. Fire damage was equally severe with the stems of standing dead trees commonly showing burnt spots.

Type 8.4. *Androstachys johnsonii* Woodland on Malvernia Escarpments

3 Stands: 71, 148, 260.

This vegetation type occurred in the south of the Park on the slopes facing the Mwenezi valley and, to the north, on the slopes of Nyamatongwe hill and in the headwaters of the Nyamasikana drainage. Its total extent was approximately 16 km^2. Three stands were investigated.

The topography consisted of moderate to steep often dissected slopes interspersed with flatter ground. The geology was Malvernia sandstone and the soils were sandy clay loam in two stands and sand with grit in the other. Termitaria were only noted in one stand, they were large and at a density of 1 to 5 per ha.



The dominant tree species was *Androstachys johnsonii* with a cover of 50 to 80%. Tree species which emerged from the *Androstachys johnsonii* canopy were mainly *Colophospermum mopane*, *Commiphora caerulea* and *Terminalia prunioides*. Other less common but typical large trees were *Berchemia discolor*, *Combretum hereroense* var. *hereroense* and *Kirkia acuminata.*

The subcanopy was formed by *Androstachys johnsonii.* Associate tree species were the same as in the canopy as well as *Acacia senegal* var. *leiorhachis*, *Manilkara mochisia* and *Pappea capensis*.

Typical species in the shrub layer, besides young trees, were *Canthium setiflorum* subsp. *setiflorum*, *Croton pseudopulchellus*, *Euclea divinorum*, *E. racemosa* subsp. *schimperi*, *Flueggea virosa* subsp. *virosa, Grewia bicolor*, *Maerua parvifolia* and *Uvaria gracilipes*.

Where there was a groundcover it consisted essentially of grass, with *Aristida rhiniochloa* and *Schmidtia pappophoroides* the most common species and *Panicum maximum* prominent in shady places.

The height of the emergent trees was up to 20 m, somewhat lower on Nyamatongwe Hill, and top canopy cover was 1 to 3%.

The bulk of the woody vegetation was in the subcanopy, its height was up to 8 m but often lower, and the cover was from 35 to 80%.

The shrub layer was sparse, varying in cover from 2 to 4 %.

Total woody cover was 35% in one stand and 65% and 80% in the other two.

The herbaceous groundcover was essentially confined to open spaces since there was mainly bare ground beneath the stands of *Androstachys johnsonii*. The cover was extremely sparse, in one stand 1 to 2% and 30 to 50% in the other two, from a distance giving the impression of a dense cover but close up the tufts of mainly *Schmidtia pappophoroides* were widely spaced.

The structure was open woodland in one stand and woodland in the other two.

The composition of the woody species showed similarities with Type 4.6.1 (Mopane mixed woodland on Malvernia steep hills and escarpments) and Type 8.2 (*Androstachys johnsonii* woodland on southern igneous rocks). With both types the three stands investigated shared between 6 to 13 species.

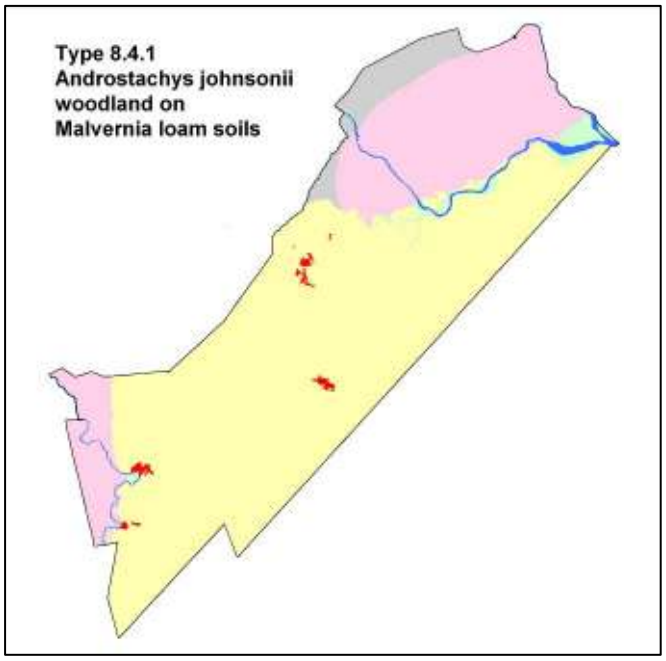
Besides the dominance of *Androstachys johnsonii,* this type was characterized by the presence of five species which occurred in all the stands, they were: *Colophospermum mopane*, *Combretum hereroense* var. *hereroense, Commiphora caerulea, Grewia bicolor* and *Terminalia prunioides*. Apart from this each stand contained between six to nine species which were not shared with either of the other two stands.

In some areas the ridges were devoid of *Androstachys johnsonii* and within the groves of *Androstachys johnsonii* there were open patches with standing dead trees, often with burnt patches on the trunks. On the slopes towards the Mwenezi valley the vegetation was heavily degraded with numerous bare areas and conspicuous erosion. On Nyamatongwe hill extensive areas of the slopes were covered with *Androstachys johnsonii* woodland. In some parts they were mainly even aged young trees, and on the whole the vegetation was relatively well preserved.

Subtype 8.4.1. *Androstachys johnsonii* Woodland on Malvernia Loam Soils

1 Stand: 76.

In the south of the park close to the contact between the igneous rock belt and the Malvernia Beds there were a number of small areas on the Malvernia Beds where the soil consisted of pebbly loam. On it there was a type of *Androstachys johnsonii* woodland that was in some respects different from the others. Additional portions were mapped scattered through the Malvernia Beds to the vicinity of Nyamatongwe in the north. The total extent was 22 km^2. Only a single stand was sampled.



The widely scattered emergent mature tree species were *Colophospermum mopane*, *Kirkia acuminata* and *Spirostachys africana* and occasional large specimens of *Androstachys johnsonii*.

The second tree layer was equally sparse consisting of *Acacia nigrescens*, *Androstachys johnsonii*, *Cassia abbreviata* subsp. *beareana*, *Colophospermum mopane*, *Combretum hereroense* var. *hereroense* and *Spirostachys africana*.

The bulk of the woody vegetation was in the shrub layer where *Androstachys johnsonii* had a cover of approximately 12%. A scrub form of *Colophospermum mopane* was also very common and had a cover of about 5% above the height of one metre and a similar cover below it. Other typical shrub species were *Dichrostachys cinerea* subsp. *africana*, *Euclea racemosa* subsp. *schimperi*, *Flueggea virosa* subsp. *virosa*, *Grewia bicolor*, *Maerua parvifolia*, *Mundulea sericea* and *Senna petersiana*. Tree species in the shrub layer besides *Androstachys johnsonii* were occasional young specimens of *Acacia tortilis* subsp. *heteracantha*, *Boscia angustifolia* var. *corymbosa*, *Cassia abbreviata* subsp. *beareana*, *Combretum hereroense* var. *hereroense* and *Spirostachys africana*.

The herbaceous groundcover was sparse, up to 10%, and consisted mainly of grass. The most common species were *Enneapogon cenchroides* and *Heteropogon contortus*.

Eight of the seventeen species recorded were shared with Type 8.2 (*Androstachys johnsonii* woodland on southern igneous rocks) and seven occurred in Type 8.4 (*Androstachys johnsonii* woodland on Malvernia escarpments). Two species recorded only in the shrub layer were confined to the type discussed here, namely *Acacia tortilis* subsp. *heteracantha* and *Mundulea sericea*. It was therefore considered best to make it a subtype although more field work is required to verify this.

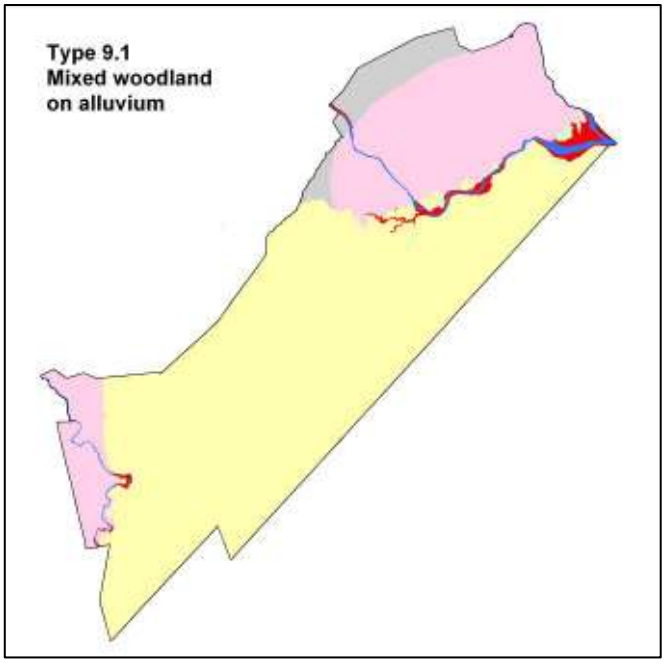
Type 9. Woodland on Alluvium

Type 9.1. Mixed Woodland on Alluvium

24 Stands: 4, 7, 64, 83, 155, 156, 182, 186, 212, 247, 248, 249, 266, 269, 282, 283, 284, 285, 287, 295, 297, 298, 302, 303.

Vegetation on alluvium was principally found along the Runde River in the north and the Mwenezi River in the south, and along the downstream reaches of several smaller tributaries. It occurred in fringing ribbons or pockets along water courses, on alluvial terraces and on flood plains. Along smaller streams it was made up of scattered individual riparian trees and shrubs, too narrow to map.

Woodland on alluvium was best developed above and around the Save/Runde junction, and near Fishans Kraal in the vicinity of the Benji River mouth. At the Save/Runde junction it extended over about 22 km^2 and constituted one of the largest expanses of this vegetation type in Zimbabwe. The total mapped area was approximately 65 km^2 in extent. Twenty-four stands were investigated.



The topography was flat alluvial terraces, gently undulating or occasionally gently or fairly steeply dipping towards the water course it fringed. The geology was alluvium and the soils were mainly clays, loamy clays or clay loams, rarely loam, sandy clay loams or sand. Large termitaria were recorded in seven stands, medium ones in six and small ones were noted in one stand. In one stand the large anthills were at a density of more than 5 per ha, in all the others they were at a density of 1 to 5 per ha.

Some of the tree species were common throughout, but there was considerable variation in the assemblages of woody plants between different localities. Common and widespread tree species in the top canopy were *Acacia tortilis* subsp. *heteracantha*, *Combretum imberbe*, *Cordyla africana*, *Kigelia africana*, *Philenoptera violacea* and *Xanthocercis zambesiaca*. Slightly less common and widespread species were *Berchemia discolor*, *Diospyros mespiliformis*, *Drypetes mossambicensis*, *Spirostachys africana* and *Trichilia emetica* subsp. *emetica*. Frequently occurring and locally common species were *Acacia nigrescens*, *A. robusta* subsp. *clavigera*, *Adansonia digitata* (not typical but quite frequently recorded) and *Strychnos potatorum*. Typical riverine species which, surprisingly, were recorded only locally were *Acacia welwitschii* subsp. *delagoensis*, *Ficus sycomorus* subsp. *sycomorus*, *Garcinia livingstonei*, *Hyphaene petersiana* and *Mimusops zeyheri*. *Acacia welwitschii* subsp. *delagoensis*, *Garcinia livingstonei* and *Mimusops zeyheri* could be common or even dominant where they occurred. *Faidherbia albida,* which typically occurred on sandbanks, was recorded in five localities. Nice stands of *Newtonia hildebrandtii* var.

pubescens were observed in two localities. *Philenoptera violacea* had a cover of 2 to 10% in six stands, *Diospyros mespiliformis* in four, *Combretum imberbe* and *Spirostachys africana* in three, and *Faidherbia albida* and *Hyphaene petersiana* in one stand each. *Cordyla africana* had a cover of 40 to 50% in one stand and 5 to 10% in two, and *Mimusops zeyheri* one of 40 to 50% in one stand.

The most common and widespread tree species in the second tree layer were *Cleistochlamys kirkii* and *Croton megalobotrys.* Slightly less frequent were *Boscia mossambicensis* (often clump forming), *Diospyros loureiriana* subsp. *loureiriana* (in two stands reaching the top canopy)*, Lecaniodiscus fraxinifolius*, *Maclura africana* (clump forming) and *Tabernaemontana elegans*. Widespread and common clump forming liana species were *Capparis sepiaria* var. *subglabra, C. tomentosa* and *Combretum mossambicense.* Less common ones were *Acacia schweinfurthii* var. *schweinfurthii*, *Combretum microphyllum*, *Hippocratea buchananii*, *H. crenata*, and *H. longipetiolata*. Occasional clump forming species were *Hippocratea africana* var. *richardiana*, and *H. indica.* In a few stands (four to six) there were also two species of slender lianas, *Bridelia cathartica* subsp. *cathartica* and *Phyllanthus reticulatus* var. *reticulatus*, both of which were twining among the clumps.

Common shrub species were *Deinbollia xanthocarpa, Flueggea virosa* subsp. *virosa* and *Thilachium africanum*. Typical but less common shrubs were *Dichrostachys cinerea* subsp. *africana, Ehretia amoena* and *Pavetta gracillima*. In some stands the two species of *Capparis* were also common as shrubs with covers of up to 15%. In one stand *Bauhinia tomentosa* had a cover of 10% and *Alchornea laxiflora* of 25%, also *Salvadora persica* var. *pubescens* had a cover of 30% in one stand and *Acalypha ornata* of 10% in another. In a number of stands *Colophospermum mopane* and *Philenoptera violacea* made significant contributions to the shrub layer, up to a cover of 10% in some localities.

The herbaceous groundcover varied greatly between the stands in both species composition and density. Equally variable was the proportion of forbs the layer contained which varied from quite scarce to more than the grass component. There was also variation in the dominance of the grass species. In well wooded stands with much shade *Panicum maximum* was dominant, sometimes interspersed with *Setaria sagittifolia*. Often dominant was *Urochloa mosambicensis* and frequently dominant or co-dominant grass species were *Chloris virgata*, *Cynodon dactylon*, *Dactyloctenium giganteum*, *Digitaria milanjiana*, *Pogonarthria squarrosa* and *Schmidtia pappophoroides*. Occasionally dominant were *Brachiaria deflexa*, *Eragrostis cylindriflora* and *E. lehmanniana*. There was a variety of forbs, often different ones in different stands. Species noted were *Abutilon grandiflorum*, *Acanthospermum hispidum* (an exotic), *Aptosimum lineare*, *Barleria elegans*, *Indigofera praticola*, *Justicia matammensis* and *Monechma debile*.

Height of the trees in the top canopy was estimated to be up to 20 m in 11 stands, 25 m in nine, 30 m in three and 30 to 40 m in one. Canopy cover was below 3% in ten stands, 5 to 15% in nine, 20 to 30% in two, 30 to 40% in one and 60% in two.

In its original state this vegetation type would have had a continuous tree canopy, thus structurally it would have constituted riparian or riverine forest. In the highly degraded stands, where canopy cover was below 20%, the large trees were irregularly and widely scattered with the distances between trees increasing with decreasing cover. In the most degraded areas (cover < 1%) large trees were extremely scarce. With better cover tree distribution became more regular and small areas with a continuous canopy became visible. The two stands with a cover of 60% contained reasonable stretches of riparian forest. Open spaces were up to 2 ha in the most degraded stands but very much smaller in the less disturbed ones.

Heights in the second tree layer were in most stands between 4 and 8 m, in a few up to 10 to 16 m. Canopy cover was 15% and below in 18 stands (0 to 3% in seven), 16 to 35% in five, and 70% in one. Again the lower the cover the wider and more haphazard was the distribution of trees. A typical feature of the vegetation on alluvium were extensive areas covered almost exclusively with large

clumps of shrubby trees and lianas twining around themselves, up to 5 to 6 m in height and essentially devoid of trees.

Shrub cover was up to 15% in nineteen stands (0 to 5% in 11), 16 to 25% in four and 40% in one.

Total woody cover was up to 10% in four stands, from 11 to 30% in 12, 31 to 60% in five and 90 to 100% in three. The last three stands would have cover values of 105%, 110 to 115% and 120 to 130% if the values estimated for each layer were added. This illustrates the layered structure of this vegetation type when in its original state or only moderately disturbed.

In four stands *Salvadora persica* var. *pubescens* was recorded, a type of liana which formed large clumps. In one stand (Stand 7) it had a cover of up to 25% and was heavily utilized by game. The area where it was plentiful was extensively degraded with large open spaces devoid of woody vegetation.

The estimated cover of the herbaceous layer varied greatly. It was up to 10% in four stands, 11 to 30% in ten, 31 to 60% in seven, and 90 to 100% in three.

The structure of this vegetation type could be described as wooded grassland, open shrubland, open woodland, woodland, or open riparian forest depending on the state of degradation.

Recent damage by elephant varied from moderate to severe. In a number of areas the woody vegetation was in the process of being opened up. Five to 10 fallen dead trees were counted per hectare and in many places up to 15 standing dead trees could be seen from one point. There was also much bare ground covered with copious arable weeds. In one locality *Acanthospermum hispidum* covered 90% of the ground.

Type 10. Special Communities on Southern Igneous Rocks

On the slopes of the rhyolite hills in the southwestern boundary area two most unusual plant communities were observed. On south facing slopes there was a vegetation type dominated by *Galpinia transvaalica* (Type 10.1), and on the north facing ones a different type in which *Lannea schweinfurthii* var. *stuhlmannii* was prominent (Type 10.2).

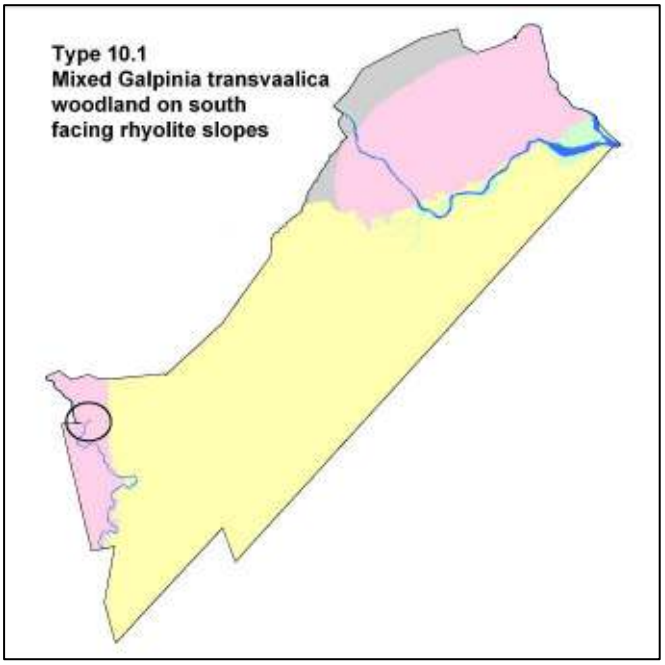
Type 10.1. Mixed *Galpinia transvaalica* Woodland on South Facing Rhyolite Slopes

1 Stand: 59.

This vegetation type was only found on south facing slopes of steep sided valleys in the igneous complex of the southwestern boundary area, and was investigated only once. A single occurrence was mapped around the sample site with an area of 0.09 km^2. A walk towards the west confirmed its occurrence in three more localities of similar environment.

The topography was a rocky 30 to 40 degree slope with occasional small cliffs and scattered rock fragments on the surface. The underlying geology was rhyolite and the soils consisted of sandy clay loam. No termitaria were noted.

Over large areas the woody vegetation consisted of shrubs and small trees only.



Top canopy trees recorded were *Acacia nigrescens, Kirkia acuminata, Spirostachys africana* (mainly on the lower slopes) and *Stadmannia oppositifolia* subsp. *rhodesica*.

Tree species in the second layer were *Combretum apiculatum, C. zeyheri, Ficus obtusifolia, Galpinia transvaalica, Lannea schweinfurthii* var. *stuhlmannii, Manilkara mochisia, Markhamia zanzibarica, Pseudolachnostylis maprouneifolia, Spirostachys africana* and *Stadmannia oppositifolia* subsp. *rhodesica. Galpinia transvaalica* was the most common tree with a cover of about 5%. *Combretum apiculatum* occurred in occasional small groups some of them consisting of fairly mature specimens.

The most common species in the shrub layer was *Grewia caffra* with a cover of about 3%. Typical shrub species were *Allophylus rubifolius* var. *rubifolius, Canthium glaucum* subsp. *frangula* var. *frangula, Cissus cornifolia, Coffea racemosa, Dichrostachys cinerea* subsp. *africana, Ehretia amoena, Euclea divinorum, E. racemosa* subsp. *schimperi, Maerua parvifolia, Pavetta gracillima, Phyllanthus pinnatus, Thilachium africanum, Tricalysia allenii* and *Xerophyta equisetoides.* There were 25 tree species recorded in the shrub layer, many of them small trees, indicating how species rich this vegetation type was.

There was a dense grass cover consisting mainly of *Aristida rhiniochloa, Digitaria milanjiana* and *Panicum maximum.* Conspicuous forbs were *Aspilia mossambicensis* and *Melhania randii.*

The cover of the woody species was irregular and the heights of the trees were staggered without a noticeable stratification. The height of the taller trees was up to 18 m and their cover was less than 10%.

The heights of the trees below the tall specimens were 3 to 7 m and their cover was about 10%.

Cover abundance of the shrub layer was about 7% and total woody cover was 17%.

The cover of the herbaceous layer, mainly grasses, was approximately 60%. Considering that there was a fair amount of surface rock the 60% indicates a very dense grass cover.

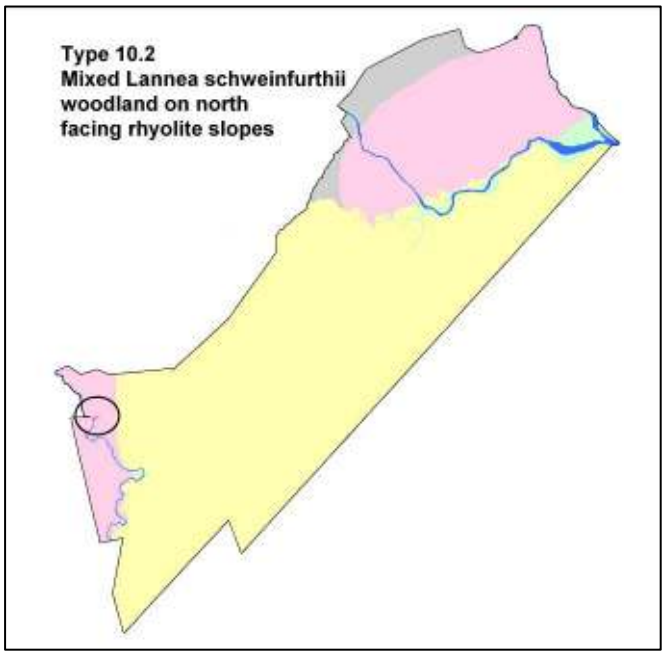
The structure of the vegetation was a wooded grassland.

Recent elephant damage was moderate, there were some standing and fallen dead trees. However, considering the enormous reduction in woody cover and woody biomass the long term damage of this extremely rare vegetation type was severe. *Galpinia transvaalica,* the dominant tree in the second layer, had only once previously been collected in Zimbabwe in the Mateke Hills some 50 km further west.

Type 10.2. Mixed *Lannea schweinfurthii* Woodland on North Facing Rhyolite Slopes

1 Stand: 60.

This vegetation type was investigated only once. It occurred in the igneous complex in the southwestern boundary area in the same valley as the Type 10.1 - mixed *Galpinia transvaalica* woodland, but on the opposite north facing slope. Its extent was 0.14 km^2. Additional patches may occur but it was not possible to map these with any certainty.



The topography was a 30 to 40 degree steep slope, with up to 50% of the land covered with outcropping rock and much loose rock on the surface especially on the lower slopes. The underlying geology was rhyolite and the soils were loamy clays. No termitaria were noted.

The dominant tree in the top canopy was *Lannea schweinfurthii* var. *stuhlmannii* with a canopy cover of about 5%. Common associate tree species were *Gyrocarpus americanus* subsp. *africanus* and *Kirkia acuminata.* Occasional trees were *Adansonia digitata, Spirostachys africana* and *Terminalia prunioides.*

In the second tree layer *Commiphora edulis* subsp. *edulis* was common. Typical trees were *Acacia nigrescens, Cassia abbreviata* subsp. *beareana, Lannea schweinfurthii* var. *stuhlmannii, Manilkara mochisia, Philenoptera violacea, Stadmannia oppositifolia* subsp. *rhodesica* and *Terminalia prunioides.* Twining clump forming liana species were *Combretum padoides* and *Hugonia orientalis*.

The dominant species in the shrub layer was *Gardenia resiniflua* subsp. *resiniflua.* Other shrub species were *Capparis tomentosa, Combretum mossambicense* (both also lianas), *Grewia bicolor, Gymnosporia putterlickioides, Hexalobus monopetalus* var. *monopetalus, Hippocratea africana* var. *richardiana, H. buchananii, Monodora junodii* var. *junodii, Phyllanthus pinnatus, Thilachium africanum* and *Tricalysia allenii.*

The herbaceous groundcover consisted mainly of grasses. The dominant grass species were *Aristida scabrivalvis* and *Panicum maximum.* Forbs recorded were *Barleria heterotricha, Melhania randii* and *Waltheria indica.*

The height of the top canopy was about 15 to 16 m, exceptionally up to 18 m. Canopy cover was estimated at about 20%.

Tree height of the second canopy was 3 to 5 m and the cover was below 5%.

The shrub layer had a cover of around 7% and the total woody cover was 30%.

The cover of the herbaceous layer was 30%.

The structure of the vegetation was open woodland.

Recent elephant damage was moderate. Long term degradation was considerable but not as severe as in most other areas.

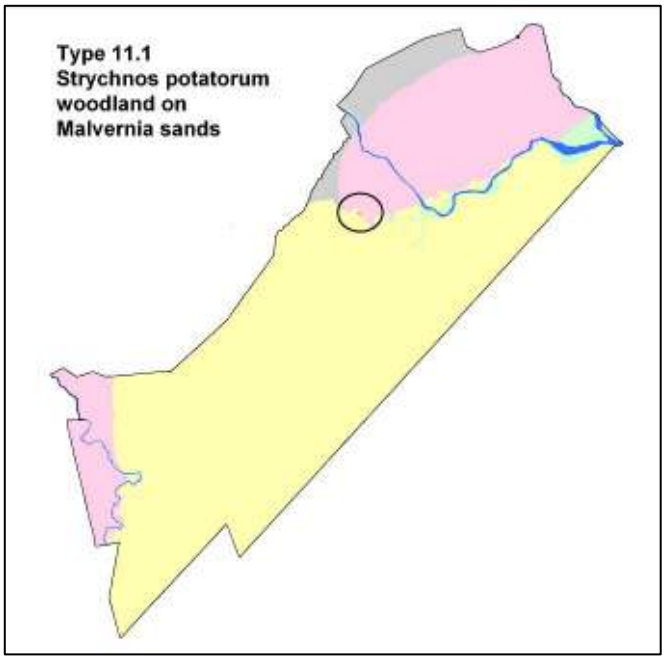
Type 11. Special Communities on Malvernia Beds

On the Malvernia Beds two most uncommon vegetation types were noted, both of very limited extent. One was situated on a low hill top on sand (Type 11.1) and the other on flat ground on a rather rare soil type underlain by calcrete (Type 11.2).

Type 11.1. *Strychnos potatorum* Woodland on Malvernia Sands

1 Stand: 268.

This vegetation type was only encountered once. It occurred a few kilometres south of Benji Weir at the very edge of the Malvernia Beds. The extent of this patch was 0.1 km^2.



The topography was a very broad, gently convex low hill top. The geology consisted of Malvernia Beds, the soils were brown sands and no surface rock was observed. There were large termitaria at a density of 1 to 5 per ha.

The top canopy trees noted were occasional *Strychnos potatorum* and very scarce *Combretum imberbe, Drypetes mossambicensis* and *Spirostachys africana.*

The second tree layer consisted mainly of decimated mature *Strychnos potatorum* and occasional dense clumps of *Markhamia zanzibarica.* Occasional associate species were *Cassia abbreviata* subsp. *beareana, Diospyros loureiriana* subsp. *loureiriana* and *Strychnos madagascariensis.* There were also widely scattered large clumps of the lianas *Capparis tomentosa* and *Combretum mossambicense.*

Shrub species recorded in the very sparse shrub layer were *Coptosperma zygoon, Flueggea virosa* subsp. *virosa, Pavetta gracillima* and *Thilachium africanum.* Tree species in the shrub layer were *Cladostemon kirkii, Diospyros loureiriana* subsp. *loureiriana, Drypetes mossambicensis, Markhamia zanzibarica, Strychnos madagascariensis, S. potatorum, S. spinosa* and *Vitex ferruginea* subsp. *amboniensis*. Lianas that formed shrubs were *Capparis sepiaria* var. *subglabra, C. tomentosa* and *Combretum mossambicense*.

In the herbaceous groundcover the grasses had been almost completely eliminated and the sparse groundcover consisted of *Ocimum americanum* var. *americanum* (an exotic), *Hemizygia bracteosa* and other forbs. Occasional grass species were *Eragrostis lehmanniana* and *Schmidtia pappophoroides.*

The height of the canopy trees was up to 18 m and canopy cover was below 1%.

In the second tree layer the trees were 3 to 8 m tall and the canopy cover was 10%.

The cover of the shrub layer was a mere 2% and the total woody cover was estimated at 10%, one of the lowest in the park.

The herbaceous ground cover was 15 to 20% which left much of the ground bare.

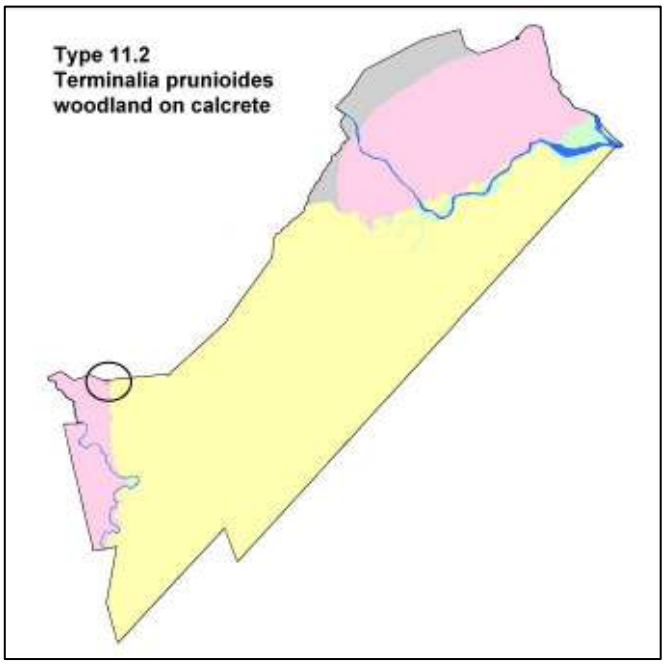
The structure of this vegetation type was wooded grassland.

Only moderate recent elephant damage was observed, but the damage by elephant and fire which had occurred over a long period was extremely severe. The species composition was depauperated to the extent that one could not even guess as to how this possibly rare and unusual vegetation type might once have looked.

Type 11.2. *Terminalia prunioides* Woodland on Calcrete

1 Stand: 221.

This vegetation type was only recorded once along the boundary road near the northwest corner of the southern part of the park. Two small portions were mapped with a combined area of 0.16 km^2.



The topography was a very gently undulating slope of up to two degrees. The geology was calcrete, most likely of the Malvernia Beds. The locality was very close to the boundary between the Malvernia Beds and the igneous complex of the southwestern border area. The soils consisted of loamy clay, at a depth of 30 to 40 cm there was a horizon of tightly packed small rock fragments. Occasional surface rock was observed. There were large termitaria at a density of 1 to 5 per ha.

The only top canopy tree noted was *Terminalia prunioides.*

The second tree layer was composed almost entirely of *Terminalia prunioides,* occasional associate species were *Colophospermum mopane, Markhamia zanzibarica* and *Spirostachys africana.* The *Terminalia prunioides* were fairly evenly spaced, approximately 50 m apart, but the lower strata of the second tree layer was conspicuously clumped delimiting open areas of 100 m^2 in extent or even larger.

The shrub layer consisted of *Canthium glaucum* subsp. *frangula* var. *frangula, Dichrostachys cinerea* subsp. *africana, Euclea racemosa* subsp. *schimperi, Flueggea virosa* subsp. *virosa, Grewia flavescens, Hippocratea buchananii, Maerua parvifolia, Gymnosporia putterlickioides, Ochna inermis, Phyllanthus pinnatus* and *Senna petersiana.* Tree species in the shrub layer were *Berchemia discolor, Colophospermum mopane, Markhamia zanzibarica, Pappea capensis, Spirostachys africana* and *Terminalia prunioides.* There was also *Combretum mossambicense,* which can be a liana or a clump forming species in the second tree layer, but very often only as a shrub.

The herbaceous ground cover consisted of a mixture of grasses and forbs.

There was one mature top canopy specimen seen, its height was approximately 15 m. Canopy cover was obviously almost zero.

The trees in the second layer were 4 to 12 m high and their cover was estimated at 15%.

The cover of the shrub layer was estimated at 15% and the total woody cover at about 30%.

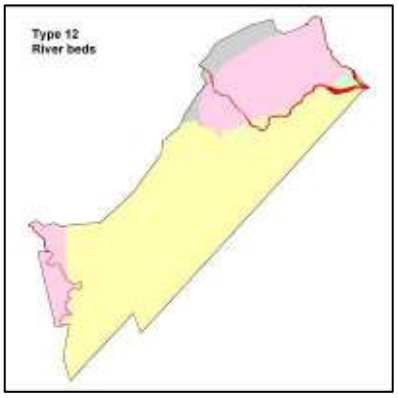
The herbaceous ground cover had a cover of about 50%.

The structure of the vegetation was open woodland tending towards wooded grassland in some areas.

This vegetation type was too degraded to show much recent elephant damage but long term fire and elephant damage was severe. Like the previous type (Type 11.1 *Strychnos potatorum* woodland) it appeared to be rare and unusual especially since its environment was seen nowhere else. Unfortunately the vegetation was too degraded to speculate on the original species assemblage.

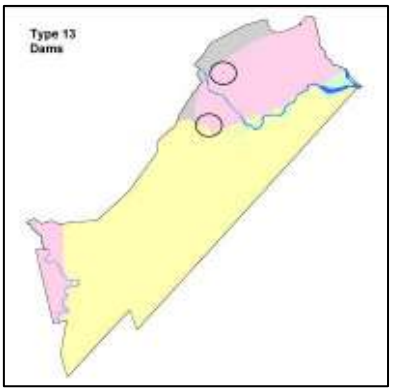
Type 12. River Beds

The river beds of the Mwenezi, Runde and Save Rivers were mapped as a separate unit. Where these rivers coincided with the Park boundary, the boundary was taken as following the centre of the river. The river beds were best developed on the lower Runde River and on the Save in the immediate vicinity of the Save-Runde junction. The total extent of river bed was approximately 62 km^2.



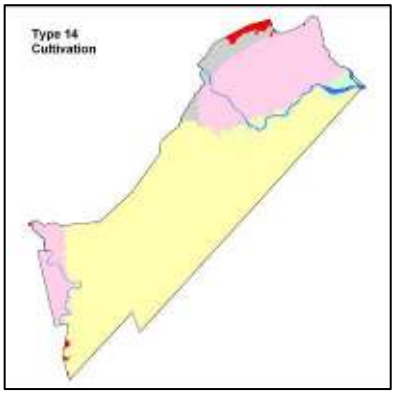
Type 13. Dams

The Park has two small artificial dams, these being Benji Weir to the south of the Runde and the Massasanya Dam within the Pombadzi area between the Save and Runde. The combined extent was about 0.1 km^2.



Type 14. Cultivation

Under the auspices of the recent land reform programme part of the Gulugi drainage to the extreme north of the Park has been settled and cultivated. Two portions were mapped here with a combined area of 39 km^2. A further five small areas were mapped to the south of the Park, principally in the Malapati area where a portion of the Park is excluded by the veterinary fence. The total extent of cultivation was about 47 km^2.



6. PLANT SPECIES

A total of 493 plant species comprising 333 woody species and 160 herbaceous species were recorded (Appendices 4 and 5). The classification of plant species as woody or herbaceous followed Drummond (1975). As noted in the methodology recording of herbaceous species was confined to the most common and prominent species rather than attempting to provide a comprehensive record.

For species distributions the following data sources were checked: the checklist of Zimbabwean vascular plants (Mapaura and Timberlake, 2004), the electronic Flora of Zimbabwe (Hyde, Wursten and Ballings, 2012), Flora Zambesiaca (1960-), the collection of specimens within the National Herbarium, Harare and the checklist of plants for the Tuli-Lower Umzingwane area (Timberlake et al., 2002). Nomenclature followed that presently in use at the National Herbarium in Harare.

In terms of plant distributions within Zimbabwe, according to the system adopted for the Flora Zambesiaca and as used by the National Herbarium in Harare, the country is divided into five floristic regions comprising the north, west, centre, south and east, designated respectively by the letters N, W, C, E and S. The southern region extends between the Shashe and Save Rivers and includes the towns and districts Gwanda, Mberengwa, Zvishivane, Chivi, Masvingo, Gutu, Buhera, Bikita, Zaka, Chiredzi, Mwenezi and Beitbridge. The immediately adjacent portion of Chipinge District to the east of the Save River comprises similar lowveld terrain but is included as part of the eastern region.

The classification of plant species as endemic or near endemic to Zimbabwe followed that of Mapaura (2002); classification in terms of IUCN standard threat categories followed that of Mapaura and Timberlake (2002); and as indigenous or naturalized followed that of Maroyi (2006), in each case including any subsequent updates as acknowledged by the National Herbarium in Harare.

6.1 Species of Conservation Interest

Among the woody species there were four new records for Zimbabwe: *Commiphora schlechteri, Croton steenkampianus* and *Putterlickia verrucosa*, plus *Gardenia* sp. c.f. *cornuta*, although fertile material is required to confirm the latter identification (Table 3). All four species are known from further south in Mozambique and South Africa, but these appear to be the first records for Zimbabwe.

An additional 12 species were recorded for the first time from southern Zimbabwe (Table 3), having previously been collected from only the north, west, centre or east of the country. These comprised 11 woody species plus the herb *Barleria aromatica*.

Fifteen of the woody species, within Zimbabwe, appear to be confined to the south of the country and nine of these appear to have only been recorded from Gonarezhou National Park, these being: *Acacia burkei, A. exuvialis, Clerodendrum pleiosciadium, Grewia hornbyi, Manilkara concolor, Periploca nigrescens, Rinorea elliptica, Schotia capitata* and *Suregada zanzibariensis* (Table 3). An additional six species within Zimbabwe are known only from Gonarezhou and the immediately adjacent area to the east of the Save River from Mahenye to Chisumbanje, these being: *Acacia welwitschii* subsp. *delagoensis, Commiphora neglecta, Croton madandensis, Leptactina delagoensis* subsp. *delagoensis, Uvaria gracilipes* and *Wrightia natalensis*.

None of the species recorded are endemic to Zimbabwe. The herb *Barleria aromatica* is classified as a near endemic species, possibly occurring also in Zambia (Mapaura, 2002).

The herb *Limeum argute-carinatum* is also confined to the south of Zimbabwe, and *Barleria elegans* is known only from the south (from Chikwarakwara, the Bubye River, Manjinji Pan and now also Gonarezhou National Park) plus Mahenye in the east of the country.

Table 3. Plant species new to Zimbabwe or new to the south of Zimbabwe, and/or with distributions restricted to southern Zimbabwe.

Species Name	Family Name	Distribution
New to Zimbabwe		
Commiphora schlechteri Engl.	BURSERACEAE	Elsewhere in Mozambique and South Africa (KwaZulu-Natal and Transvaal)
Croton steenkampianus Gerstner	EUPHORBIACEAE	Elsewhere Mozambique, South Africa (KwaZulu-Natal) and eastern Tanzania
Gardenia sp. c.f. cornuta	RUBIACEAE	Fertile material required to confirm identification. Elsewhere in Mozambique, South Africa (Kwa-Zulu-Natal) and Swaziland
Putterlickia verrucosa (E.Mey. ex Sond.) Szyszyl.	CELASTRACEAE	Elsewhere Mozambique and South Africa (Kwa-Zulu-Natal, E. Transvaal, E. Cape Province)
New to Southern Zimbabwe		
Barleria aromatica Oberm.	ACANTHACEAE	Previously NWCE, Zimbabwe near endemic
Brackenridgea zanguebarica Oliv.	OCHNACEAE	Previously E
Commiphora caerulea Burtt	BURSERACEAE	Previously NW
Commiphora neglecta I.Verd.	BURSERACEAE	Previously E
Croton menyharthii Pax	EUPHORBIACEAE	Previously NEW
Erythrococca menyharthii (Pax) Prain	EUPHORBIACEAE	Previously NWC
Ficus bussei Warb. ex Mildbr. & Burret	MORACEAE	Previously NE
Hippocratea parviflora N.E.Br.	CELASTRACEAE	Previously NW
Neoholstia tenuifolia (Pax) Rauschert var. tenuifolia	EUPHORBIACEAE	Previously NCE
Oncoba spinosa Forssk.	FLACOURTIACEAE	Previously NWC
Pteleopsis anisoptera (Welw. ex M.A.Lawson) Engl. & Diels	COMBRETACEAE	Previously NWC
Ruspolia seticalyx (C.B.Clarke) Milne-Redh.	ACANTHACEAE	Previously NEW
In Zimbabwe confined to the south		
Acacia burkei Benth.	FABACEAE	Confined to Gonarezhou
Acacia exuvialis I.Verd.	FABACEAE	Confined to Gonarezhou
Boscia foetida Schinz subsp. rehmanniana (Pestal.) Toelken	CAPPARACEAE	West to Shashe-Limpopo junction
Clerodendrum pleiosciadium Gü rke	LAMIACEAE	Confined to Gonarezhou
Coptosperma littorale (Hiern) Degreef	RUBIACEAE	North to Nyoni Hills
Euclea natalensis A.DC. subsp. angustifolia F.White	EBENACEAE	West to Shashe-Limpopo junction
Galpinia transvaalica N.E.Br.	LYTHRACEAE	West to Mateke Hills
Grewia caffra Meisn.	TILIACEAE	North and West to Humani Ranch and Mateke Hills
Grewia hornbyi Wild	TILIACEAE	Confined to Gonarezhou
Manilkara concolor (Harv.) Gerstner	SAPOTACEAE	Confined to Gonarezhou
Periploca nigrescens Afzel.	APOCYNACEAE	Confined to Gonarezhou
Rinorea elliptica (Oliv.) Kuntze	VIOLACEAE	Confined to Gonarezhou
Schotia capitata Bolle	FABACEAE	Confined to Gonarezhou
Sideroxylon inerme L. subsp. diospyroides (Baker) J.H.Hemsl.	SAPOTACEAE	West to Dumela/Limpopo River
Suregada zanzibariensis Baill.	EUPHORBIACEAE	Confined to Gonarezhou
In Zimbabwe confined to Gonarezhou and immediately east of the Save River (E Zimbabwe)		
Acacia welwitschii Oliv. subsp. delagoensis (Harms) J.H.Ross & Brenan	FABACEAE	Recorded also in Mahenye
Commiphora neglecta I.Verd.	BURSERACEAE	Known elsewhere from a single hill in Chisumbanje
Croton madandensis S.Moore	EUPHORBIACEAE	Recorded also near Chisumbanje
Leptactina delagoensis K.Schum. subsp. delagoensis	RUBIACEAE	Recorded also near Hippo mine
Uvaria gracilipes N.Robson	ANNONACEAE	Recorded also in Mahenye
Wrightia natalensis Stapf	APOCYNACEAE	Recorded also from Chisumbanje

Twenty-three of the woody species, plus the herb *Barleria aromatica*, are classified as red data species within Zimbabwe (Table 4). According to IUCN's standard threat categories these included four critically endangered species (*Commiphora neglecta , Periploca nigrescens*, *Rinorea elliptica* and *Schotia capitata*), two endangered species (*Adenium multiflorum* and *Milicia excelsa*), five vulnerable species (*Acacia exuvialis*, *Adenia fruticosa* subsp. *simplicifolia*, *Manilkara concolor*, *Pachypodium saundersii* and *Suregada zanzibariensis*), plus six species categorized as Lower Risk Near Threatened, four as Lower Risk Least Concern, and three species characterized as Data Deficient.

Table 4. Plant species Classified as Red Data Species in Zimbabwe.

Species Name	Family Name	IUCN Threat Category	Zimbabwe Distribution
Acacia exuvialis I.Verd.	FABACEAE	Vulnerable	S (GNP)
Adenia fruticosa Burtt Davy subsp. simplicifolia W.J.de Wilde	PASSIFLORACEAE	Vulnerable	ES
Adenium multiflorum Klotzsch	APOCYNACEAE	Endangered	NWES
Afzelia quanzensis Welw.	FABACEAE	Lower Risk least concern	NWCES
Barleria aromatica Oberm.	ACANTHACEAE	Data Deficient	NWCES
Canthium racemulosum S.Moore var. racemulosum	RUBIACEAE	Lower Risk near threatened	ES
Commiphora neglecta I.Verd.	BURSERACEAE	Critically Endangered	ES
Croton madandensis S.Moore	EUPHORBIACEAE	Data Deficient	ES
Dalbergia melanoxylon Guill. & Perr.	FABACEAE	Lower Risk near threatened	NWCES
Deinbollia xanthocarpa (Klotzsch) Radlk.	SAPINDACEAE	Lower Risk near threatened	NES
Euphorbia griseola Pax subsp. griseola	EUPHORBIACEAE	Lower Risk least concern	NWCES
Jatropha spicata Pax	EUPHORBIACEAE	Data Deficient	ES
Leptactina delagoensis K.Schum. subsp. delagoensis	RUBIACEAE	Lower Risk least concern	ES
Manilkara concolor (Harv.) Gerstner	SAPOTACEAE	Vulnerable	S (GNP)
Milicia excelsa (Welw.) C.C.Berg	MORACEAE	Endangered	ES
Pachypodium saundersii N.E.Br.	APOCYNACEAE	Vulnerable	ES
Periploca nigrescens Afzel.	APOCYNACEAE	Critically Endangered	S (GNP)
Pterocarpus angolensis DC.	FABACEAE	Lower Risk near threatened	NWCES
Rinorea elliptica (Oliv.) Kuntze	VIOLACEAE	Critically Endangered	S (GNP)
Schotia capitata Bolle	FABACEAE	Critically Endangered	S (GNP)
Stadmannia oppositifolia (Lam.) Poir. Subsp. rhodesica Exell	SAPINDACEAE	Lower Risk near threatened	ES
Suregada zanzibariensis Baill.	EUPHORBIACEAE	Vulnerable	S (GNP)
Uvaria gracilipes N.Robson	ANNONACEAE	Lower Risk near threatened	ES
Wrightia natalensis Stapf	APOCYNACEAE	Lower Risk least concern	ES

Combining the above categories of new records for Zimbabwe and the south of Zimbabwe, plus species confined to the south of Zimbabwe or to Gonarezhou plus the immediately adjacent area to the east of the Save River, plus the red data species, yields an overall total of 47 woody taxa that can be considered to be of conservation interest or significance. Collectively, a total of 561 records were made for these 47 woody species of interest. The distribution of these species of interest and records by vegetation types and general geology are shown in Tables 5 and 6.

One or more species of interest were recorded from 36 out of the overall 41 types and subtypes, the exceptions being Subtypes 4.1.1 and 4.8.1 (which were not sampled) and Subtype 8.4.1 and Types 11.1 and 11.2 (each of which were represented by only a single sample). Total records of species of interest for other types and subtypes varied from one (Subtypes 3.1.1, 5.1.1 and 6.1.1 and Type 10.2) to a maximum of 71 for Type 1.2 (Table 5).

The numbers of samples per type also varied widely from one (for seven types or subtypes) to a maximum of 38 samples for Type 1.2. Across all 330 samples the mean number of records of species of interest per sample was 1.7. Types showing markedly higher than average records per sample were Subtype 1.1.1 ($x = 3.0$), Type 2.3 ($x = 3.6$), Type 3.1 ($x = 3.4$), Type 4.6.1 ($x = 3.2$), Type 8.2.1 ($x = 2.5$), Type 8.4 ($x = 4.0$) and Type 10.1 ($x = 4.0$).

The number of species of interest recorded from the 37 types or subtypes in which they were found varied from one to a maximum of 15 species for Type 5.1. Other types with relatively high numbers of species of interest were Type 1.2 ($n = 14$), Subtype 4.6.1 ($n = 12$), Type 9.1 ($n = 11$) and Types 2.3, 3.1, 4.6, 8.1 and 8.4 ($n = 10$) each.

Types to which one or more species of interest were restricted were Type 9.1 (five species), Types 1.2, 8.1 and 8.4 (two species each) and Types/Subtypes 1.1.1, 1.3, 4.6, 4.8, 5.1 and 10.1 with one species each.

Overall, there were twentyfive types and subtypes with no or relatively few records of species of interest, with relatively few species of interest, and lacking in any unique species of interest. These were Types 1.1, 2.1 and 2.2 and Subtype 1.1.2 on Malvernia sands; Subtype 3.1.1 and seven of the mopane types on igneous rocks, Malvernia loam to clay soils, Malvernia sands and alluvium (Types 4.1, 4.2, 4.3, 4.4, 4.5, 4.7 and 4.9); five of the mixed woodland types and subtypes on the northern granophyre (Types 5.2, 5.3 and 6.1, Subtypes 5.1.1 and 6.1.1); the two *Combretum apiculatum* types

on igneous rocks to the north and south (Types 7.1 and 7.2); three of the *Androstachys johnsonii* woodland types on igneous rocks to the south, Malvernia sands and Malvernia loam soils (Types 8.2 and 8.3 and Subtype 8.4.1), plus the three special Types 10.2, 11.1 and 11.2.

The remaining fourteen types and subtypes with greater presence of species of conservation interest were Subtypes 1.1.1, Type 1.2, Type 1.3, Type 2.3 and Type 3.1 on Malvernia sands; Type 4.6, Subtype 4.6.1, Type 4.8 and Type 8.4 on Malvernia pebbly loam soils, Malvernia escarpments and Malvernia drainage lines; Types 5.1 and 8.1 on the northern granophyre; Subtype 8.2.1 and Type 10.1 on southern igneous rocks; and Type 9.1 on alluvium.

The overall distribution of species of interest in relation to the constituent five broad geological regions (alluvium, Malvernia sands, Malvernia heavier soils and escarpments, and igneous rocks to the north and south) is shown in Table 6. The Malvernia sands had the highest number of records (n = 266) and alluvium the lowest (n = 31). When standardized in terms of numbers of samples, the portions with the highest mean records of species of interest per sample were the Malvernia heavier soils and escarpments (x = 1.9) and the Malvernia sands (x = 1.8).

Of the total 47 species of interest, the highest occurrence was 24 species from the Malvernia sands, followed by 20 species each from the Malvernia heavier soils and escarpments and the igneous north portion. In terms of unique species of interest, only one species was confined to the igneous south portion with the other four regions having six to eight unique species each.

6.2 Species Diversity

In terms of overall numbers of species, the highest number of species was recorded from Type 5.1 (n = 162), perhaps on account of this probably being a composite type which should have been further subdivided but which due to extensive degradation was not possible (Table 5). Other types with high numbers of species were Type 1.1 (n = 99), Type 1.2 (n = 136), Type 1.3 (n = 104), Type 3.1 (n = 118), Type 4.6 (n = 95) and Subtype 4.6.1 (n = 123), Type 4.7 (n = 106) and Type 9.1 (n = 149). Generally these were all types with relatively high numbers of samples (between 8 and 38), although Types 1.1, 3.1, Subtype 4.6.1 and possibly Type 9.1 stand out as having higher numbers of species than might be expected for the respective numbers of samples (8 to 24 samples). The remaining types all had less than 90 species, and other than Type 4.5 were represented by less than 10 samples.

The mean number of species recorded per sample, for all 330 samples, was 27. Type 10.1 had the highest value with 52 species being recorded from the single sample for this type. Other relatively diverse types were Type 2.3 (x = 31), Type 3.1 (x = 44), Subtype 4.6.1 (x = 31), Type 5.1 (x = 38), Type 5.2 (x = 43), Type 7.2 (x = 31), Type 8.1 (x = 32), Type 8.2 (x = 31), Type 9.1 (x = 32) and Type 10.2 (x = 31). The types with the lowest numbers of species per sample were Subtype 3.1.1 (x = 16), Type 4.1 (x = 16), Type 4.3 (x = 19), Type 4.5 (x = 18), Type 4.9 (x = 19) and Type 8.4.1 (x = 17), all of which occurred on heavier textured loam to clay soils.

The overall distribution of woody species in relation to the constituent five broad geological regions (alluvium, Malvernia sands, Malvernia heavier soils and escarpments, and igneous rocks to the north and south) is shown in Table 7. The Malvernia sands had the highest number of records (n = 3671) and the lowest number was recorded from the southern igneous region (n = 778). When standardized in terms of numbers of samples, the portions with the highest mean records of woody species per sample were the igneous north (x = 33.0) and alluvial (x = 31.8) areas, followed by the Malvernia sands (x = 25.3), the igneous south (x = 25.1) and the Malvernia heavier soils and escarpments (x = 20.5), the latter three groups all being below the overall mean of 26.5 species per sample.

Of the total 333 woody species, the highest number were recorded from the northern igneous portion (n = 220) followed by the Malvernia sands (n = 209), the alluvium (n = 185), the Malvernia heavier soils and escarpments (n = 177) and finally the southern igneous portion (n = 177) (Table 7). In terms

of unique woody species, only six species were confined to the igneous south portion, 16 species to the Malvernia heavier soils and escarpments, and between 23 to 29 species for each of the remaining three regions.

Table 5. Occurrence of Woody Plant Species of Conservation Interest by Vegetation Types.

Vegetation type	0	1.1	1.1.1	1.1.2	1.2	1.3	2.1	2.2	2.3	3.1	3.1.1	4.1	4.2	4.3	4.4	4.5	4.6	4.6.1	4.7	4.8	4.9	5.1	5.1.1	5.2	5.3	6.1	6.1.1	7.1	7.2	8.1	8.2	8.2.1	8.3	8.4	8.4.1	9.1	10.1	10.2	11.1	11.2	Total
Acacia burkei		3			4	4	1	2	2	1									1			2																		20
Acacia exuvialis																	18	8															1							27
Acacia welwitschii subsp. delagoensis	1	2			6								3									5				3						1			3					24
Adenia fruticosa subsp. simplicifolia																						1							2			1								4
Adenium multiflorum													1					1				4							1						1					8
Afzelia quanzensis				1	3			1	1						1				1			5					1		1	3	2				1	1				22
Boscia foetida subsp. rehmanniana	1	3	2	1	12	2	3	1	3	4				2		1	1	1	3	4		1						1		3		1	1							51
Brackenridgea zanguebarica					1																																			1
Canthium racemulosum var. racemulosum																						4		1		1			2											8
Clerodendrum pleiosciadium		2	3	1	5																																			11
Commiphora caerulea																		8															2							10
Commiphora neglecta																																	1							1
Commiphora schlechteri																																	1							1
Coptosperma littorale							1		5									1				2		1					1											11
Croton madandensis														1								1											1							3
Croton menyharthii																		1															1							2
Croton steenkampianus			1																																					1
Dalbergia melanoxylon		2			8	13	1		1	6		6	2	5	4	4	19	3	12	2	1	6			2	2	1	2	2		1					3					108
Deinbollia xanthocarpa																																				14					14
Erythrococca menyharthii		3		2	13	1	2		1	5						1	1		7	1																					37
Euclea natalensis subsp. angustifolia					8	19	2	2	3	4								2	1	2	1																				44
Euphorbia griseola subsp. griseola																													1												1
Ficus bussei																																				1					1
Galpinia transvaalica																																					1				1
Gardenia sp. c.f. Cornuta																	1																								1
Grewia caffra	1		1		1							1	1	3	3			2		1		9	1			2		5	4	3	3	1					1				43
Grewia hornbyi		1										1				1	1		2																					6
Hippocratea parviflora																					1																				1
Jatropha spicata																												1		1										2
Leptactina delagoensis subsp. delagoensis		1	1	1	1				3																															7
Manilkara concolor						1				1								2										1												5
Milicia excelsa																																				1					1
Neoholstia tenuifolia var. tenuifolia										2	1						1															1			1					6
Oncoba spinosa																						1																			1
Pachypodium saundersii																						2							1												3
Periploca nigrescens																																				1					1
Pteleopsis anisoptera					1																																				1
Pterocarpus angolensis						5																																			5
Putterlickia verrucosa					1	2																																			3
Rinorea elliptica																																				1					1
Ruspolia seticalyx																													1												1
Schotia capitata										1							1																								2
Sideroxylon inerme subsp. diospyroides																	4	3															1								8
Stadmannia oppositifolia subsp. rhodesica																						2									1					1	1			5
Suregada zanzibariensis									4	1																															5
Uvaria gracilipes		2			7	10		2	2	2						2	2	3	1			1											2		1					37
Wrightia natalensis			1	1																											2	1							5

Vegetation type	0	1.1	1.1.1	1.1.2	1.2	1.3	2.1	2.2	2.3	3.1	3.1.1	4.1	4.2	4.3	4.4	4.5	4.6	4.6.1	4.7	4.8	4.9	5.1	5.1.1	5.2	5.3	6.1	6.1.1	7.1	7.2	8.1	8.2	8.2.1	8.3	8.4	8.4.1	9.1	10.1	10.2	11.1	11.2	Total
SPECIES OF CONSERVATION INTEREST																																								
Total Records	**3**	**19**	**9**	**7**	**71**	**57**	**10**	**8**	**25**	**27**	**1**	**8**	**7**	**11**	**8**	**9**	**49**	**35**	**28**	**10**	**3**	**46**	**1**	**2**	**2**	**8**	**1**	**10**	**7**	**14**	**11**	**5**	**4**	**12**	**0**	**28**	**4**	**1**	**0**	**0**	**561**
Number of samples	2	13	3	3	38	31	9	4	7	8	1	9	8	5	7	13	25	11	22	6	4	22	2	3	2	5	1	9	5	7	6	2	5	3	1	24	1	1	1	1	330
Number of records per sample	**1.5**	**1.5**	**3.0**	**2.3**	**1.9**	**1.8**	**1.1**	**2.0**	**3.6**	**3.4**	**1.0**	**0.9**	**0.9**	**2.2**	**1.1**	**0.7**	**2.0**	**3.2**	**1.3**	**1.7**	**0.8**	**2.1**	**0.5**	**0.7**	**1.0**	**1.6**	**1.0**	**1.1**	**1.4**	**2.0**	**1.8**	**2.5**	**0.8**	**4.0**	**0.0**	**1.2**	**4.0**	**1.0**	**0.0**	**0.0**	**1.7**
Total species of conservation interest	**3**	**9**	**6**	**6**	**14**	**9**	**6**	**5**	**10**	**10**	**1**	**3**	**4**	**4**	**3**	**5**	**10**	**12**	**8**	**5**	**3**	**15**	**1**	**2**	**1**	**4**	**1**	**5**	**3**	**10**	**5**	**3**	**4**	**10**	**0**	**11**	**4**	**1**	**0**	**0**	**47**
Number of species per sample	1.5	0.7	2.0	2.0	0.4	0.3	0.7	1.3	1.4	1.3	1.0	0.3	0.5	0.8	0.4	0.4	0.4	1.1	0.4	0.8	0.8	0.7	0.5	0.7	0.5	0.8	1.0	0.6	0.6	1.4	0.8	1.5	0.8	3.3	0.0	0.5	4.0	1.0	0.0	0.0	0.1
Number of unique species			**1**		**2**	**1**											**1**			**1**		**1**								**2**				**2**		**5**	**1**				**17**
ALL WOODY SPECIES																																									
Vegetation type	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**Total**
Total woody plant species	**53**	**99**	**36**	**47**	**136**	**104**	**83**	**55**	**80**	**118**	**16**	**55**	**71**	**45**	**71**	**84**	**95**	**123**	**106**	**87**	**51**	**162**	**42**	**87**	**30**	**67**	**26**	**87**	**71**	**87**	**74**	**33**	**55**	**46**	**17**	**149**	**52**	**31**	**22**	**20**	**333**
Number of samples	2	13	3	3	38	31	9	4	7	8	1	9	8	5	7	13	25	11	22	6	4	22	2	3	2	5	1	9	5	7	6	2	5	3	1	24	1	1	1	1	330
Mean number of species per sample	**30**	**24**	**20**	**27**	**26**	**23**	**28**	**25**	**31**	**44**	**16**	**16**	**23**	**19**	**24**	**18**	**20**	**31**	**24**	**29**	**19**	**38**	**27**	**43**	**22**	**29**	**26**	**27**	**31**	**32**	**31**	**23**	**20**	**22**	**17**	**32**	**52**	**31**	**22**	**20**	**27**

Table 6. Occurrence of Woody Plant Species of Conservation Interest by General Geology.

Geological Region	Alluvium	Malvernia Sands	Malvernia Clays, Loams and Escarpments	Igneous North	Igneous south	Total
Vegetation types	4.9/ 9.1	1.1/ 1.1.1/ 1.1.2/ 1.2/ 1.3/ 2.1/ 2.2/ 2.3/ 3.1/ 4.7/ 8.3/ 11.1	4.5/ 4.6/ 4.6.1/ 4.8/ 8.4/ 8.4.1/ 11.2	4.1/ 4.2/ 5.1/ 5.1.1/ 5.2/ 5.3/ 6.1/ 6.1.1/ 7.1/ 8.1	3.1.1/ 4.1/ 4.3/ 4.4/ 7.2/ 8.2/ 8.2.1/ 10.1/ 10.2	**39**
Acacia burkei		18		2		**20**
Acacia exuvialis			27			**27**
Acacia welwitschii subsp. delagoensis	3	9		12		**24**
Adenia fruticosa subsp. simplicifolia		1		3		**4**
Adenium multiflorum	1		1	6		**8**
Afzelia quanzensis	1	7		7	7	**22**
Boscia foetida subsp. rehmanniana		36	8	1	6	**51**
Brackenridgea zanguebarica		1				**1**
Canthium racemulosum var. racemulosum				8		**8**
Clerodendrum pleiosciadium		11				**11**
Commiphora caerulea			10			**10**
Commiphora neglecta			1			**1**
Commiphora schlechteri			1			**1**
Coptosperma littorale		6	1	4		**11**
Croton madandensis			1	2		**3**
Croton menyharthii			2			**2**
Croton steenkampianus		1				**1**
Dalbergia melanoxylon	4	43	28	19	14	**108**
Deinbollia xanthocarpa	14					**14**
Erythrococca menyharthii		34	3			**37**
Euclea natalensis subsp. angustifolia	1	39	4			**44**
Euphorbia griseola subsp. griseola				1		**1**
Ficus bussei	1					**1**
Galpinia transvaalica					1	**1**
Gardenia sp. c.f. Cornuta			1			**1**
Grewia caffra		2	3	23	15	**43**
Grewia hornbyi		3	2	1		**6**
Hippocratea parviflora	1					**1**
Jatropha spicata				2		**2**
Leptactina delagoensis subsp. delagoensis		7				**7**
Manilkara concolor		2	2	1		**5**
Milicia excelsa	1					**1**
Neoholstia tenuifolia var. tenuifolia	1	2	2		1	**6**
Oncoba spinosa				1		**1**
Pachypodium saundersii				3		**3**
Periploca nigrescens	1					**1**
Pteleopsis anisoptera		1				**1**
Pterocarpus angolensis		5				**5**
Putterlickia verrucosa		3				**3**
Rinorea elliptica	1					**1**
Ruspolia seticalyx				1		**1**
Schotia capitata		1	1			**2**
Sideroxylon inerme subsp. diospyroides			8			**8**
Stadmannia oppositifolia subsp. rhodesica				2	3	**5**
Suregada zanzibariensis		5				**5**
Uvaria gracilipes	1	26	9	1		**37**
Wrightia natalensis		3			2	**5**
Total records woody species of interest	**31**	**266**	**115**	**100**	**49**	**561**
Number of samples	28	145	60	66	31	**330**
No of records of woody SOI per sample	**1.1**	**1.8**	**1.9**	**1.5**	**1.6**	**1.7**
Total woody species of interest	**13**	**24**	**20**	**20**	**8**	**47**
Unique woody species of interest	**6**	**8**	**7**	**6**	**1**	**28**
Number of woody SOI per sample	0.5	0.2	0.4	0.3	0.3	**0.1**

Table 7. Occurrence of All Woody Plant Species by General Geology.

ALL WOODY SPECIES	Alluvium	Malvernia Sands	Malvernia Clays, Loams and Escarpments	Igneous North	Igneous South	Total
Total records of woody species	**890**	**3671**	**1229**	**2180**	**778**	**8748**
Total number of samples	28	145	60	66	31	**330**
Mean number of records of woody species per sample	**31.8**	**25.3**	**20.5**	**33.0**	**25.1**	**26.5**
Total number of woody species	**185**	**209**	**177**	**220**	**139**	**333**
Number of unique woody species	**29**	**25**	**16**	**23**	**6**	**99**
Mean number of unique woody species per sample	1.0	0.2	0.3	0.3	0.2	**0.3**

6.3 Exotic Species

Fourteen exotic species were recorded comprising five woody species *Euphorbia tirucalli*, *Lantana camara, Senna occidentalis, S. septemtrionalis* and *Withania somnifera*, and nine herbaceous species *Acanthospermum hispidum, Alternanthera pungens, Corchorus trilocularis, Datura stramonium, Euphorbia heterophylla, Ocimum americanum* var. *americanum, Sida cordifolia, Sorghum halepense* and *Xanthium strumarium* (Table 8).

Table 8. Exotic plant species recorded within Gonarezhou National Park.

Species Name	Family Name	Zimbabwe Distribution	Notes
Woody species			
Euphorbia tirucalli L.	EUPHORBIACEAE	NWCES	
Lantana camara L.	VERBENACEAE	NWCES	A declared noxious weed in Zimbabwe
Senna occidentalis (L.) Link	FABACEAE	NWCES	
Senna septemtrionalis (Viv.) Irwin & Barneby	FABACEAE	WCES	
Withania somnifera (L.) Dunal	SOLANACEAE	NWCES	
Herbaceous species			
Acanthospermum hispidum DC.	ASTERACEAE	NWCES	
Alternanthera pungens Kunth	AMARANTHACEAE	NWCES	
Corchorus trilocularis L.	TILIACEAE	NWCES	
Datura stramonium L.	SOLANACEAE	NWCES	
Euphorbia heterophylla L.	EUPHORBIACEAE	NWCES	
Ocimum americanum L. var. americanum	LAMIACEAE	NWCES	
Sida cordifolia L.	MALVACEAE	NWCES	
Sorghum halepense (L.) Pers.	POACEAE	NWCES	
Xanthium strumarium L.	ASTERACEAE	NWCS	

One or more exotic species were recorded from 28 out of the 330 samples (8%), with an overall total of 31 observations (Table 9). These records were spread across 13 types, with a single species being recorded from 11 of the types, two species from Type 4.5 Mopane Woodland on Malvernia Heavier Textured Soils and eight species from Type 9.1 Mixed Woodland on Alluvium. Most exotic species were recorded from only a single vegetation type, other than *Euphorbia heterophylla* and *Ocimum americanum* var. *americanum* (2 types each) and *Euphorbia tirucalli* (4 types).

Table 9. Occurrence of exotic plant species by vegetation types and samples.

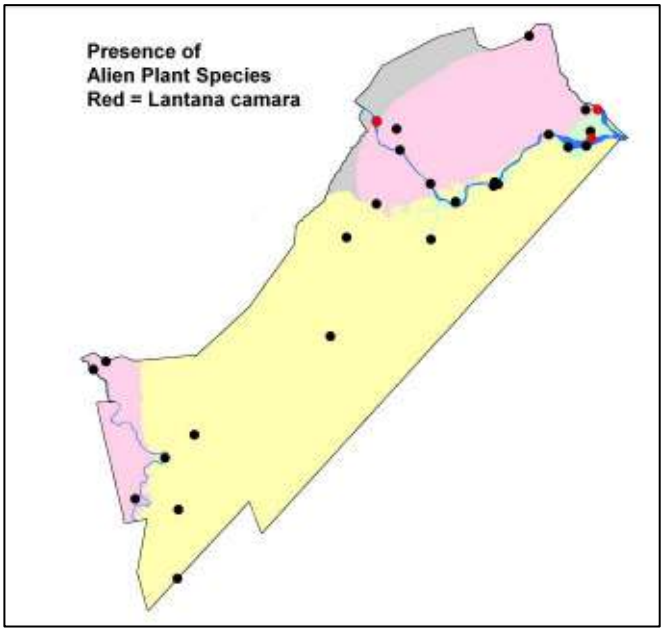
Species name	Number of Records	Vegetation Type	Sample Numbers
Corchorus trilocularis	1	1.3	254
Ocimum americanum var. americanum	1	4.3	19
Ocimum americanum var. americanum	1	4.5	169
Sida cordifolia	1	4.5	228
Euphorbia heterophylla	1	4.6	56
Ocimum americanum var. americanum	1	4.7	73
Alternanthera pungens	1	4.8	54
Euphorbia tirucalli	4	5.1	17, 188, 301, 326
Euphorbia tirucalli	1	5.2	192
Euphorbia tirucalli	1	7.2	217
Sorghum halepense	1	8.1	8
Euphorbia heterophylla	1	8.2.1	35
Acanthospermum hispidum	2	9.1	83, 212
Datura stramonium	1	9.1	83
Euphorbia tirucalli	2	9.1	247, 248
Lantana camara	3	9.1	247, 295, 302
Senna occidentalis	2	9.1	4, 282
Senna septemtrionalis	3	9.1	285, 287, 297
Withania somnifera	1	9.1	303
Xanthium strumarium	1	9.1	83
Ocimum americanum var. americanum	1	11.1	268
Total	**31**	**13**	**28**

In terms of general geology there were 15 records of eight exotic species were from alluvium (all Type 9.1); six records of three species from three igneous north types; four records of three species from three Malvernia heavier soils and escarpments types, and three records of three species each from three igneous south types and Malvernia sand types (Table 10).

Table 10. Occurrence of exotic plant species by general geology.

General Geology	Vegetation Types	Number of Species	Number of Records
Alluvium	9.1	8	15
Malvernia sands	1.3, 4.7, 11.1	3	3
Malvernia heavier soils and escarpments	4.5, 4.6, 4.8,	3	4
Igneous north	5.1, 5.2, 8.1,	3	6
Igneous south	4.3, 7.2, 8.2.1	3	3
Total	**13**	**14**	**31**

Map 14. Locations where exotic species were recorded.



Of the exotic species *Lantana camara* is by far the greatest concern, being an aggressive invader that in places forms impenetrable thickets to the exclusion of most other species, and which is extremely difficult to eradicate. The three records for *Lantana camara* were all from Type 9.1 mixed woodland on alluvium, once at Chipinda Pools camp site and the other two in the vicinity of the Save-Runde junction.

Outside of any samples *Opuntia ficus-indica* (L.) Mill. was observed growing along the banks of the Mwenezi River in proximity to Stand 86. Additional cactus species were observed in vicinity of both Mabalauta and Chipinda Pools Camps, apparently having been introduced as garden plants and subsequently escaped into the adjacent areas. Every effort should be made to ensure the removal of these species.

7. DISCUSSION

The findings of the present survey, in this section, are presented and discussed in the context of previous works relating to the GNP; to adjacent areas in Zimbabwe; to the national framework presented in the survey of communal lands to the north and west of the country, and in relation to the Kruger National Park in South Africa and the Limpopo, Banhine and Zinave National Parks in Mozambique (Section 7.1). This context is important to assessing the conservation significance of the constituent vegetation types (Section 7.2). Thereafter, consideration is given to the status of vegetation resources (Section 7.3), particularly the massive reduction of trees and the possible causes and resulting impacts of this (Section 7.4), and of possible broad management options to address the ongoing degradation of vegetation resources (Section 7.5). The final two sections provide brief comments on the methodology used for the study (Section 7.6) and ideas for additional work that would further enrich understanding of vegetation resources within the GNP (Section 7.7).

7.1 Comparison to Other Studies

Gonarezhou National Park. The existing vegetation map for GNP (Sherry, 1970) is largely based on earlier work by Farrell (1968) which covered a more extensive part of the Save-Runde region, within the GNP extending south to the Mwenezi-Sango railway line. Farrell described 22 vegetation types for this area, of which 20 units (14 types and four subtypes, plus cultivation and rivers) were mapped within what is now the GNP.

Sherry (1970) modified and extended this map to cover the whole of the GNP including the Mabalauta portion to the south of the railway line. This map shows 15 vegetation types (plus rivers), 13 of which correspond directly to Farrell's earlier types or subtypes (Mopane woodland, Mopane scrub/ *Enneapogon*, Dry deciduous sandveld woodland and scrub, *Brachystegia glaucescens* woodland, *Julbernardia globiflora* woodland, *Androstachys johnsonii* thicket, *Kirkia, Commiphora, Adansonia* open woodland, *Guibourtia conjugata* woodland, *Guibourtia conjugata/Baphia obovata* thicket, *Acacia nigrescens/Acacia welwitschii* tree savanna, Riverine and alluvial woodland, *Spirostachys africana/Terminalia prunioides* woodland and *Millettia stuhlmannii* woodland), plus two additional ones, Mopane sandveld ecotone complex and *Combretum fragrans/Terminalia stenostachya* open woodland (Table 11). Of the two additional ones, the former occurs only to the west outside of the area mapped by Farrell, whilst the latter was recognized by Farrell but not mapped within Gonarezhou. Six of Farrell's original units were not recognized by Sherry (1970), these being *Combretum mossambicense* woodland, *Combretum apiculatum* woodland, *Acacia tortilis* tree savanna and *Hyphaene ventricosa* woodland, cultivation and *Setaria porphyrantha* grassland.

Comparing with the current study, two of Sherry's (1970) map units are not represented on the present map, these being *Kirkia, Commiphora, Adansonia* open woodland and *Millettia stuhlmannii* woodland. The portion of the northern granophyre previously mapped as *Kirkia, Commiphora, Adansonia* open woodland is now subdivided and mapped under Types 4.2, 5.1 and 7.1 rather than being recognized as a separate distinctive unit. *Millettia stuhlmannii* was occasionally encountered during the present study, but on consideration of associate species was mapped as part of the surrounding Type 1.1 (*Guibourtia conjugata*) or Type 2.1 (*Brachystegia-Julbernardia*) woodlands rather as a distinct type on its own. For Sherry's other 13 units, broad parallels can be drawn with specific types or subtypes of the present study (Table 11). As before, the present map does not recognize Farrell's *Setaria porphyrantha* grassland (described by Farrell as occurring on heavy soils derived from basalt and rhyolite but mapped on Malvernia Beds, and now mapped as Type 4.6), *Acacia tortilis* tree savanna (now included as part of Type 9.1 mixed woodland on alluvium) and *Hyphaene ventricosa* woodland (also included as part of Type 9.1). The previous presence of *Acacia tortilis* woodlands along parts of the Runde River was confirmed during the course of the present study by both Charlie Mackie and Clive Stockil (pers. comm.), but these have apparently since been

eliminated by elephants. Thus, whilst *Acacia tortilis* was commonly recorded in the present study it was never sufficiently abundant or widespread to warrant recognition as a distinct subtype. Also of interest is that Farrell's *Combretum mossambicense* unit, which was not recognized by Sherry (1970), corresponds clearly to Type 1.3 Mixed Combretaceae woodland often with *Burkea africana* of the present study. The portion on the northern granophyre mapped by Farrell as *Combretum apiculatum* corresponds to *Combretum fragrans/Terminalia stenostachya* woodland in Sherry 1970, and to Type 5.3 Mixed Combretaceae woodland on granite in the present study.

Table 11. Comparison of GNP vegetation types between the present study and those of Sherry (1970) and Farrell (1959).

Present Study	Sherry (1970) Existing Map	Farrell (1959) Original Map
1.1 1.1.1 1.1.2 1.2 1.3	*Guibourtia conjugata* woodland *Guibourtia conjugata/Baphia obovata* thicket Dry deciduous sandveld woodland and scrub	11 *Guibourtia conjugata* 11b *Guibourtia conjugata-Baphia obovata* 8e *Combretum apiculatum-Pteleopsis myrtifolia* 9 *Combretum mossambicense* woodland
2.1 2.2 2.3	*Julbernardia globiflora* woodland	4 *Julbernardia globiflora*
3.1 3.1.1	*Spirostachys africana/Terminalia prunioides* woodland	15c *Spirostachys africana-Terminalia prunioides*
4.1 4.1.1 4.2 4.3 4.4 4.5 4.6 4.6.1 4.7 4.8 4.8.1 4.9	Mopane woodland Mopane scrub/*Enneapogon* Mopane sandveld ecotone complex	6 *Colophospermum mopane* 6a Stunted *Colophospermum mopane*
5.1 5.1.1 5.2 5.3	*Brachystegia glaucescens* woodland *Combretum fragrans/Terminalia stenostachya* open woodland	3 *Brachystegia glaucescens* 8 *Combretum apiculatum*
6.1 6.1.1	*Acacia nigrescens/Acacia welwitschii* tree savanna	16 *Acacia nigrescens* tree savanna
7.1 7.2		
8.1 8.2 8.2.1 8.3 8.4	*Androstachys johnsonii* thicket	12 *Androstachys johnsonii*
9.1	Riverine and alluvial woodland	21 Riparian forests 18 *Acacia tortilis* tree savanna 20 *Hyphaene ventricosa*
10.1 10.2		
11.1 11.2		
12	Rivers	Rivers
13		
14		Cultivation
	Kirkia, Commiphora, Adansonia open woodland	5 *Kirkia acuminata-Commiphora mollis*
	Millettia stuhlmannii woodland	13 *Millettia stuhlmannii*
		7 *Setaria porphyrantha* grassland
44 map units	**16 map units**	**20 map units**

The northern Pombadzi granophyre portion has been mapped in greater detail by both Farrell (1959) and Clegg (2003, in Dunham, 2005), both of whom recognize a wider diversity of vegetation types than for the present study (Table 12).

The current study includes seven types or subtypes (Subtype 3.1.1 plus Types 4.2, 5.1, 6.1, 7.1, 8.1 and 9.1) for the area mapped by Farrell 1959, and for which Farrell mapped 14 types, including *Acacia-Spirostachys* streamside zone (= Type 3.1.1), mopane woodland (= Type 4.2), Mopane-*Combretum* woodland (= Type 7.1) and riverine fringe (= Type 9.1). In other cases two or more of Farrell's units are now incorporated under a single unit: *Brachystegia-Androstachys* woodland, *Brachystegia-Gardenia* woodland and mixed woodland as Type 5.1, *Acacia nigrescens* wooded grassland and *Acacia nigrescens* woodland as Type 6.1, and *Androstachys* woodland and mixed *Androstachys* woodland as Type 8.1. Farrell also mapped vlei grasslands (observed in the field but not mapped here), cultivation (within Matibi 2 Communal Land outside of the present study area), plus a rather uncertain unit to the south called *Acacia*-mixed woodland of unknown composition.

Table 12. Comparison of Pombadzi vegetation types between present study and those of Farrell (1959) and Clegg (2003, in Dunham, 2005).

Present Study	Farrell 1959	Clegg (2003, in Dunham, 2005)
Type 3.1.1	(2) Acacia-Spirostachys streamside zone	(Not mapped)
Type 4.1		Colophospermum mopane-Urochloa mosambicensis
		Colophospermum mopane on shallow rocky soils
Type 4.1.1	(5a) Mopane woodland	Colophospermum mopane-Hyphaene petersiana
Type 4.2		Colophospermum mopane-Brachiaria eruciformis
		Colophospermum mopane-Combretum apiculatum
		Colophospermum mopane-Vitex ferruginea
Type 4.9	Not mapped	Colophospermum mopane on alluvium
Type 5.1	(7a) Brachystegia-Androstachys woodland	Acacia erubescens
	(7b) Brachystegia-Gardenia woodland	Hugonia orientalis-Lonchocarpus bussei
	(8b) Mixed woodland	
Type 5.1.1	Outside mapped area	Millettia usaramensis-Markhamia acuminata
Type 5.2	Outside mapped area	Brachystegia glaucescens
Type 5.3	Outside mapped area	Combretum zeyheri-Terminalia stenostachya
Type 6.1	(4a) Acacia nigrescens wooded grassland	Combretum imberbe-Spirostachys africana
	(4b) Acacia nigrescens woodland	
Type 6.1.1		
Type 7.1	(5b) Mopane-Combretum woodland	Combretum apiculatum
Type 8.1	(6) Androstachys woodland	Androstachys johnsonii
	(8a) Mixed Androstachys woodland	
Type 9.1	(1) Riverine fringe	Faidherbia albida
		Adansonia digitata-Salvadora persica
		Dense riverine
		Open riverine
		Short palm
		Tall palm
		Old cultivation land
Type 12	Not mapped	Water
Not mapped	(3) Vlei grassland	(not mapped)
Outside present area	(9) Cultivation	(not mapped)
Not mapped	(10) Acacia-mixed woodland of uncertain composition	(not mapped)
14 units	**14 units**	**23 units**

Clegg's work covered the whole of the Pombadzi region and depicted 23 vegetation types which are now mapped as 11 types. Types common to both studies were Type 4.1.1 (*Colophospermum mopane-Hyphaene petersiana*), Type 4.8 (*Colophospermum mopane* on alluvium), Type 5.1.1 (*Millettia usaramensis-Markhamia acuminata*), Type 5.2 (*Brachystegia glaucescens*), Type 5.3 (*Combretum zeyheri-Terminalia stenostachya*), Type 6.1 (*Combretum imberbe-Spirostachys africana*), Type 7.1 (*Combretum apiculatum*), Type 8.1 (*Androstachys johnsonii*) and Type 12 (water). Additional types mapped by Clegg correspond to subdivisions of Type 9.1 alluvial woodland into seven types (*Faidherbia albida*, *Adansonia digitata-Salvadora persica*, dense riverine, open riverine, short palm, tall palm and old cultivation land), Type 4.2 as three types (*Colophospermum mopane-Brachiaria eruciformis*, *Colophospermum mopane-Combretum apiculatum* and *Colophospermum mopane-Vitex ferruginea*), Type 4.1 as two types (*Colophospermum mopane-Urochloa mosambicensis* and *Colophospermum mopane* on shallow rocky soils) and Type 5.1 also as two types (*Acacia erubescens* and *Hugonia orientalis-Lonchocarpus bussei*).

Whilst it may be possible to distinguish additional vegetation types for this portion, given the high levels of disturbance and modification of the vegetation, to do so reliably would require considerably more effort than was possible under the present study.

Adjacent Areas in Zimbabwe. Vegetation has been mapped and described for three parts of the immediately adjacent areas to the GNP in Zimbabwe, these being Sengwe Communal Land to the south and the Mahenye Ward of Ndowoyo Communal Land to the East of the Save River (Mapaure and Chipano, 1999), at a coarser scale, and to the north Malilangwe at a finer scale (Clegg, 2010). For Mahenye Ward, Mapaure and Chipano (1999) recorded seven vegetation types. Four of these correspond directly to existing types of the present study, namely Type 4.1 mopane woodland on basalt and other igneous rocks on heavy clay soils, Type 4.2 mopane woodland on northern igneous rocks on clay loam soils, Type 5.2 *Brachystegia tamarindoides* woodland on granite and Type 9.1 mixed woodland on alluvium. Other types recognized in the Pombadzi region under this survey but which were not noted in Mahenye Ward were Types/Subtypes 5.1, 5.1.1, 5.3, 6.1, 6.1.1, 7.1 and 8.1. Interestingly one small patch of *Guibourtia conjugata* woodland on alluvial sands was noted, as was one patch in the present survey near the Save-Runde junction (this was mapped as part of Type 1.1 *Guibourtia conjugata* woodland on Malvernia sands). Two additional types were recorded in Mahenye Ward which are not recognized in the present survey, these being *Julbernardia globiflora* woodland on granophyre ridges and *Acacia-Hyphaene petersiana* shrubland on alluvium, comprising part of the Rupembi swamps that extend south into Mozambique.

Malilangwe together with the adjacent Chizvirizvi Resettlement Area and Sangwe Communal Land, mainly share the basalt communities of the GNP (Types 4.1 and 4.1.1), although for Malilangwe these have been mapped in greater detail (Clegg, 2010). In the field there is a striking fence line contrast between the mopane communities on Malilangwe and the immediately adjacent parts of the GNP, presumably due to higher elephant pressure within the GNP which has resulted in a marked lowering and opening of the tree canopy. The communal land and resettlement area portions are intensively cultivated and grazed by cattle and goats, as now is the neighbouring Gulugi portion within the GNP. Further to the north, Malilangwe and Sangwe Communal Land (and continuing to parts of the Save Valley Conservancy) include portions of Karoo and Umkondo sedimentary deposits and portions of gneiss, which are not represented in the GNP and can be expected to support different vegetation types from those of the GNP. Altogether, Clegg (2010) recognizes a total of 39 vegetation types for Malilangwe as a whole.

Between the Runde and Mwenezi Rivers, the southern and northern portions of the GNP are bounded by the surrounding broad basalt bed (Types 4.1 and 4.1.1), but for the central portion to either side of the railway line the Malvernia Beds continue north into the Gonakudzingwa Small Scale Commercial Farms and Matibi 2 Communal Land in a roughly semi circular shape, up to a maximum of about 20 km to the north of the GNP boundary into Matibi 2 Communal Land. The area of these Malvernia Beds outside of the GNP is roughly 600 km^2 and, although it has not been mapped in detail, from examination of satellite imagery it appears to include portions of sand Types 1.1, 1.2, 1.3 and 2.2 and mopane Types 4.5, 4.6 and 4.7. Much of the Matibi 2 portion is included under the Naivasha concession which is used for sport hunting.

The southern igneous complex extends for some 40 km to the west of the Mwenezi River to the Mateke Hills, such that the major portion of this igneous outcrop is within the neighbouring Sengwe Communal Land and former commercial farming areas, with only limited presence within the GNP. It is likely that the constituent Types/Subtypes 3.1.1, 4.1, 4.1.1, 4.3, 4.4, 7.2, 8.2 and 8.2.1 are all represented within this adjacent portion, possibly with additional types not found within the GNP. Guy (1958) identified six main vegetation types for the area between the Bubye River and the Mateke Hills these being (1) mopane scrub on shallow soils; (2) riverine forest on alluvium; (3) *Colophospermum – Kirkia – Sclerocarya* woodland on deeper dry soils; (4a) Mateke Hills north

comprising *Androstachys johnsonii* forests and thickets on granophyre and (4b) Mateke Hills south comprising mixed woodland on granophyre; (5) ancient cultivated lands and (6) Karoo sandstone including dense thickets of *Androstachys johnsonii* alternating with open areas with large *Afzelia quanzensis* and *Kirkia acuminata* and with *Spirostachys africana* along nearly every water channel.

To the extreme southwest the Malvernia Beds extend south into Sengwe Communal Land covering the strip between the GNP and the international boundary with Mozambique, and west to the Mwenezi River and beyond for about 10 km to just short of the Limpopo River, covering a total area of roughly 500 km^2. These portions mainly comprise mopane woodland Types 4.6, together with Types 4.5 and 4.7, but small portions of Type 1.1 *Guibourtia conjugata* woodland are known to occur, and along the Mwenezi River there are likely to be portions of Type 9.1 riparian woodlands on alluvium.

Mapaure and Chipano (1999) recognized eight vegetation types from the southern portion of Sengwe Communal Land and adjacent part of Tshipise Communal Land to the west. This portion includes Karoo sandstone and mudstone deposits that are not represented within the GNP. Three units are mapped for these Karoo areas, *Colophospermum mopane–Combretum* woodlands, *Androstachys johnsonii* thicket and Combretaceae mixed woodland. The other five types recognized correspond to Type 1.1 (*Colophospermum mopane-Guibourtia conjugata* woodland on Cretaceous sandstone), Type 4.1 (*Colophospermum mopane-Combretum* woodland on basalt), Type 4.6 (*Colophospermum mopane* mixed woodland on Cretaceous sandstone) and Type 9.1 (*Acacia-Faidherbia albida* riparian woodland on alluvium and *Acacia-Hyphaene petersiana* shrubland and cultivation on alluvium).

The status of the vegetation in the areas adjacent to the GNP is not known. Parts of the communal lands and resettlement areas are subject to intensive cultivation and grazing by livestock. In other parts, including Malilangwe and parts of Mahenye Ward and Matibi 2 and Sengwe Communal Lands, current densities of elephants are markedly lower than within the GNP, such that the vegetation of these areas could feasibly be in better condition as compared to adjacent portions within the GNP.

The Sengwe and Gonakudzingwa/Matibi 2 Communal Land occurrences represent the only other portions of Malvernia Beds in Zimbabwe outside of the GNP.

Elsewhere in Zimbabwe. Timberlake, Nobanda and Mapaure (1993), based on their survey of communal lands to the north and west of the country, provide an overall framework for vegetation classification in the country. Nine physiognomic-floristic classes of vegetation were recognized. Six of these classes appear to be represented within the GNP (Table 13), other than Class A moist forests, Class E miombo-mopane woodlands and Class J grasslands. There are clear parallels between Type 1 *Guibourtia conjugata* woodlands and Class C dry forests and thickets; Type 2 and Class D, both miombo woodlands; Type 4 and Class F, both mopane woodlands; Type 5 mixed woodlands on northern igneous rocks and Class D miombo woodlands; and Type 9 mixed woodland on alluvium and Class B riparian forests and alluvial woodlands. For the remaining four types, Type 3 *Spirostachys africana* woodlands are probably best fitted under Class B riparian forests and alluvial woodlands; Type 6 mixed woodlands on northern igneous rocks on heavier soils under Class H *Acacia* open woodlands; Type 7 *Combretum apiculatum* woodlands as Class G Combretaceae open woodlands; and Type 8 *Androstachys johnsonii* woodlands as Class C dry forests and thickets.

Neighbouring Parts of Mozambique and South Africa. The depiction of vegetation types in the regional Flora Zambesiaca map (Wild and Barbosa, 1968) is too broad to make useful comparisons between Zimbabwe and the adjacent portions of South Africa and Mozambique. More detailed studies exist for the Kruger National Park in South Africa (35 landscape types, Gertenbach, 1993), and for the Limpopo (15 vegetation types, Stalmans, Gertenbach and Carvalho-Serfontein, 2004), Banhine (11 vegetation types, Stalmans and Wishart, 2005) and Zinave (10 vegetation types, Stalmans and Peel, 2010) National Parks in Mozambique. A broad assessment of the occurrence of the nine major types

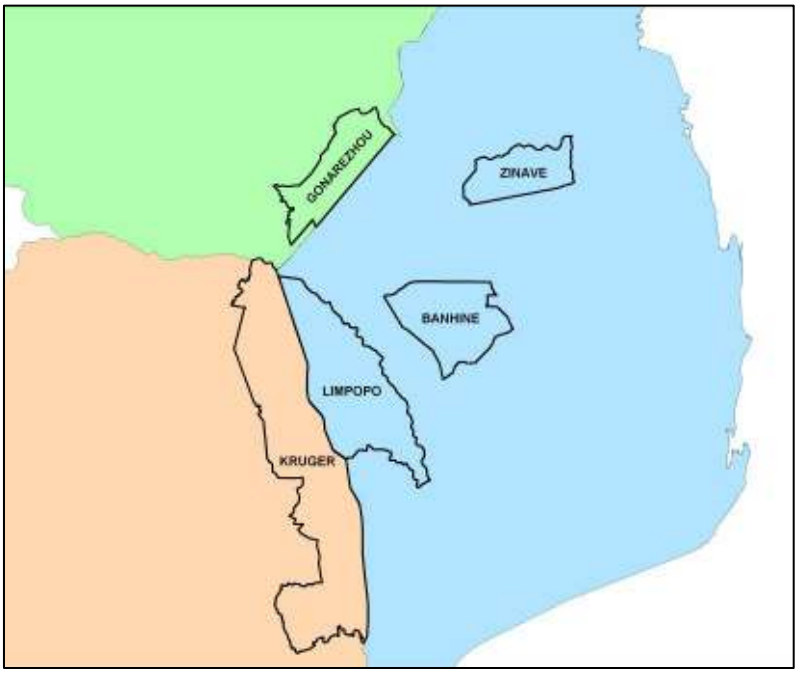
recognized for the GNP under the present study within these other areas is presented in Table 14. The comparison omits additional types described from these areas that are not represented within the GNP.

Table 13. Comparison of main vegetation types with broad vegetation classes recognized from the north and west of Zimbabwe.

GNP Vegetation Types	North and West Zimbabwe
Type 1 *Guibourtia conjugata* woodland	Class C – Dry forests and thickets
Type 2 Miombo woodland	Class D – Miombo woodlands
Type 3 *Spirostachys africana* woodland	Class B(?) – Riparian forests and alluvial woodlands
Type 4 *Colophospermum mopane* woodland	Class F – Mopane woodlands
Type 5 Mixed woodland on northern igneous rocks	Class D – Miombo woodlands
Type 6 Mixed woodland on northern igneous rocks on heavier soils	Class H (?) – Acacia open woodlands
Type 7 *Combretum apiculatum* woodland	Class G (?) – Combretaceae open woodlands
Type 8 *Androstachys johnsonii* woodland	Class C (?) – Dry forests and thickets
Type 9 Mixed woodland on alluvium	Class B – Riparian forests and alluvial woodlands

In general, the Malvernia Beds extend south into Mozambique but with unknown extent as these merge into similar but younger undifferentiated sedimentary deposits of coastal origin. The expression of Malvernia Beds within the Kruger National Park is extremely limited, being confined to an irregular narrow strip along part of the eastern boundary. Conversely, the three national parks in Mozambique are virtually lacking in any older igneous rocks as found to the north and south of the GNP, other than a narrow tongue of rhyolite along part of the western border of the LNP, whereas basement geology covers the major part of the KNP, and with greater variety of rock types as compared to the GNP. Alluvial deposits are common to all three countries particularly along the Limpopo and Save Rivers.

Map 15. Location of Gonarezhou in relation to neighbouring large regional parks.



Common to all five areas are Type 1 *Guibourtia conjugata* woodlands (minor extent in the KNP), Type 4 *Colophospermum mopane* woodlands and Type 9 mixed woodland on alluvium (Table 14). Type 8 *Androstachys johnsonii* woodlands are reported from all four areas other than Zinave NP, albeit on soils derived sometimes from sedimentary deposits (GNP, LNP and Banhine) and sometimes from igneous rocks (GNP and KNP). Type 3 *Spirostachys africana* woodlands are reported from the GNP, KNP and Banhine; Type 7 *Combretum apiculatum* woodlands from the GNP, KNP and LNP, and Type 2 Miombo woodlands only from GNP and Zinave NP. The two main types on the northern granophyre portion of the GNP, Type 5 Mixed woodland on northern igneous rocks and Type 6 Mixed woodlands on northern igneous rocks on heavier soils do not appear to be represented in any of these other regional parks.

Table 14. Presence of vegetation types recognized under the present study in protected areas in neighbouring portions of South Africa and Mozambique.

GNP Vegetation Types	GNP	KNP	LNP	Banhine	Zinave
Type 1 *Guibourtia conjugata* woodland	X	X	X	X	X
Type 2 Miombo woodland	X	-	-	-	X
Type 3 *Spirostachys africana* woodland	X	X	-	X	-
Type 4 *Colophospermum mopane* woodland	X	X	X	X	X
Type 5 Mixed woodland on northern igneous rocks	X	-	-	-	-
Type 6 Mixed woodland on northern igneous rocks on heavier soils	X	-	-	-	-
Type 7 *Combretum apiculatum* woodland	X	X	X	-	-
Type 8 *Androstachys johnsonii* woodland	X	X	X	X	-
Type 9 Mixed woodland on alluvium	X	X	X	X	X

7.2 Conservation Significance

The plant communities occurring on the Malvernia Beds, which comprise the bulk of the recognized types and cover the major part of the Park, do not occur elsewhere in the country, other than for limited parts of the neighbouring Matibi 2/Gonakudzingwa and Sengwe areas, and for which their status is uncertain. These communities are essentially unique within Zimbabwe, and some possibly do not occur anywhere else including within the neighbouring countries. Accordingly, all Malvernia types should be considered as conservation priorities (Types/Subtypes 1.1, 1.1.1, 1.1.2, 1.2, 1.3, 2.1, 2.2, 2.3, 3.1, 4.5, 4.6, 4.6.1, 4.7, 4.8, 4.8.1, 8.3, 8.4, 8.4.1)

The Type 5 *Brachystegia tamarindoides* woodlands and associated Type 6 mixed woodlands on heavier soils on the northern granophyre are not represented elsewhere in the neighbouring countries. Within Zimbabwe there is a minor extension to the east into the adjacent part of Mahenye Ward. Although *Brachystegia tamarindoides* woodlands are also reported from Malilangwe (Clegg, 2010) and the Save Valley Conservancy (du Toit, 1989 and 1994), these occur on different geological deposits (Karoo and Umkondo sandstones and granite kopjes) and are likely to be substantially different from the *Brachystegia tamarindoides* woodlands within the GNP. As such these types should also be considered as conservation priorities (Types/Subtypes 5.1, 5.1.1, 5.2, 5.3, 6.1, 6.1.1).

The communities that do appear to be better represented elsewhere in Zimbabwe and the region are those occurring on basalt (Types 4.1 and 4.1.1), and other communities on the northern and southern igneous intrusions, namely the mopane Types 4.2, 4.3 and 4.4, *Combretum apiculatum* Types 7.1 and 7.2, *Androstachys johnsonii* Types 8.1, 8.2 and 8.2.1, and Type 9.1 mixed woodland on alluvium. These communities could be considered to comprise lower conservation priorities.

Additional consideration should, however, be given to Type 9.1 mixed woodland on alluvium. Although similar riparian woodlands occur widely in the country and region, they are typically confined in extent, and serve as key areas for crop production, grazing of livestock and wildlife, and for tourism purposes, such that where they do occur they have often been highly modified and impacted. The riparian woodlands in the GNP, in particular the portion around the Save-Runde junction, comprise one of the largest and most diverse areas of alluvial woodland in the country. Together with the constituent Tembwehata and Machiniwa Pans this area has been designated as one of 20 Important Bird Areas for Zimbabwe, on the basis of regularly supporting a significant number of range restricted bird species (Childes and Mundy, 1997). As such this area should be considered as a conservation priority.

Types 10 and 11 represent special communities of very limited extent that are necessarily of high conservation interest.

There is no set methodology for assessing specific conservation priorities of different vegetation types. Possible considerations include aspects such as spatial occurrence, extent, species richness, species diversity, species of conservation interest, current status and level of threat. Current status and level of threat appear consistently high throughout the Park. Results of a subjective analysis based on distribution, extent and species composition is shown in Table 15.

Table 15. Overall conservation priority for vegetation types (1 = highest), based on subjective assessment of general distribution, extent and species composition (species richness, species diversity per stand and no of species of interest) per vegetation type.

Type	Distribution	Size (km2)	No of Species	Species per plot	Species of interest	Overall
1.1	**Restricted to Malvernia Beds**	536.05	**99**	24	**9**	3
1.1.1	**Restricted to Malvernia Beds**	108.38	36	20	6	
1.1.2	**Restricted to Malvernia Beds**	61.64	47	27	6	
1.2	**Restricted to Malvernia Beds**	557.67	**136**	26	**14**	3
1.3	**Restricted to Malvernia Beds**	423.18	**104**	23	**9**	
2.1	**Restricted to Malvernia Beds**	**27.45**	**83**	28	6	3
2.2	**Restricted to Malvernia Beds**	**27.55**	55	25	5	
2.3	**Restricted to Malvernia Beds**	**11.22**	**80**	**31**	**10**	1
3.1	**Restricted to Malvernia Beds**	66.79	**118**	**44**	**10**	2
3.1.1	Likely wider national/regional distribution	**3.33**	16	16	1	
4.1	Wider national/regional distribution	193.94	55	16	3	
4.1.1	Wider national/regional distribution	**23.29**				
4.2	Likely wider national/regional distribution	230.07	71	23	4	
4.3	Likely wider national/regional distribution	**41.27**	45	19	4	
4.4	Likely wider national/regional distribution	57.93	71	24	3	
4.5	**Restricted to Malvernia Beds**	632.85	**84**	18	5	
4.6	**Restricted to Malvernia Beds**	583.38	**95**	20	**10**	3
4.6.1	**Restricted to Malvernia Beds**	**14.75**	**123**	**31**	**12**	1
4.7	**Restricted to Malvernia Beds**	274.9	**106**	24	**8**	3
4.8	**Restricted to Malvernia Beds**	63.78	**87**	29	5	
4.8.1	**Restricted to Malvernia Beds**	**8.87**				
4.9	Wider national/regional distribution	**28.54**	51	19	3	
5.1	**Restricted to northern granophyre**	572.66	**162**	**38**	**15**	2
5.1.1	**Restricted to northern granophyre**	**28.72**	42	27	1	
5.2	**Restricted to northern granophyre**	**25.7**	**87**	**43**	2	2
5.3	**Restricted to northern granophyre**	**43.89**	30	22	1	
6.1	**Restricted to northern granophyre**	88.27	67	29	4	
6.1.1	**Restricted to northern granophyre**	**0.02**	26	26	1	
7.1	Likely wider national/regional distribution	**28.58**	**87**	27	5	
7.2	Likely wider national/regional distribution	**18.46**	71	**31**	3	
8.1	Likely wider national/regional distribution	**31.65**	**87**	**32**	**10**	2
8.2	Likely wider national/regional distribution	80.73	74	**31**	5	
8.2.1	Likely wider national/regional distribution	**25.04**	33	23	3	
8.3	**Restricted to Malvernia Beds**	**46.32**	55	20	4	
8.4	**Restricted to Malvernia Beds**	**15.55**	46	22	**10**	3
8.4.1	**Restricted to Malvernia Beds**	**21.79**	17	17	0	
9.1	Wider national/regional distribution	65.28	**149**	**32**	**11**	3
10.1	**Restricted special community**	**0.09**	52	**52**	4	3
10.2	**Restricted special community**	**0.14**	31	**31**	1	3
11.1	**Restricted special community**	**0.1**	22	22	0	
11.2	**Restricted special community**	**0.16**	20	20	0	

The values highlighted for each parameter are those of greatest conservation interest: restricted distribution, small size and high species richness, diversity and numbers of species of specific conservation interest. The overall conservation status for each type is based on the number of high ranked criteria for each type, where a score of 1 is allocated to those types for which all five parameters are scored as high and represents highest conservation interest, 2 is given to those types for which four out of five parameters are ranked as high, and 3 to those for which three parameters are ranked as high. According to this subjective assessment the highest priority vegetation types are Type 2.3 *Brachystegia tamarindoides* woodland on Malvernia sands and Type 4.6.1 mopane mixed woodland on Malvernia steep hills and escarpments, followed by Type 3.1 *Spirostachys africana* woodland on Malvernia sands, Type 5.1 mixed *Brachystegia tamarindoides* woodland on northern igneous rocks, Type 5.2 *Brachystegia tamarindoides* woodland on granite and Type 8.1 *Androstachys johnsonii* woodland on northern igneous rocks, all as second priority, and then Types 1.1, 1.2, 2.1, 4.6,

4.7, 8.4, 9.1, 10.1 and 10.2 as a third priority. It must be stressed that this is a subjective assessment and that alternative methodologies could produce different outcomes.

7.3 Vegetation Status

Looking back on seventy-five days of assessing the vegetation in Gonarezhou National Park, the overriding impression which stands out above all others is the enormous habitat degradation which has taken place over most of the park.

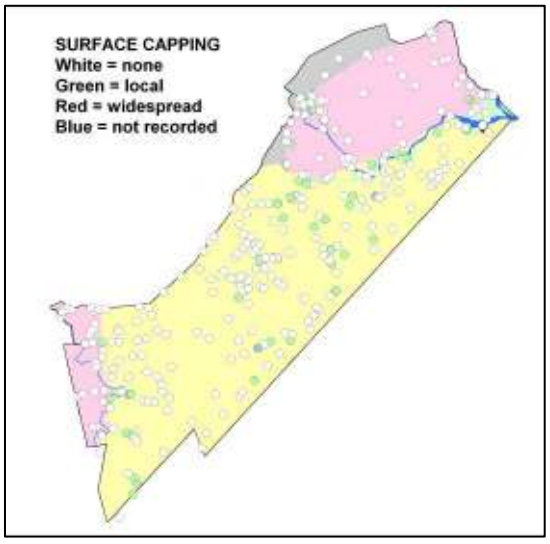
A number of parameters relating to degradation of the physical environment and vegetation were assessed for each sample, comprising the extent of soil surface capping, sheet erosion and gully erosion, the presence of alien plants, evidence of fire, evidence of grazing and browsing, evidence of current damage to trees, plus an overall assessment of vegetation status. Additional evidence was recorded in the form of field notes. Areas of recent settlement/ cultivation were mapped but not sampled.

The overall occurrence of these disturbance parameters for all 330 samples is shown in Table 16. There is a very clear split between disturbances to the physical environment, which were relatively limited, and those relating directly to the vegetation which were widespread throughout the Park. Evidence of sheet erosion was recorded for 16% of samples, surface capping for 12% and gully erosion for 6%. By contrast signs of burning were noted for 85% of samples, grazing and browsing for 96% and destruction of trees from all samples. The presence of one or more alien plants was noted from 9% of samples.

Table 16. Forms and levels of degradation of the environment and vegetation recorded as percentages of samples.

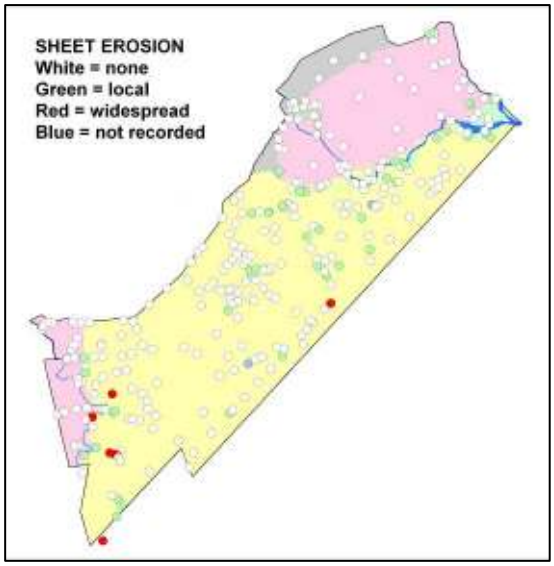
Type of Disturbance	Not Recorded	None	Present	Low	Medium	High
Gully erosion	1	93	**6**	5	0	1
Alien plants	0	91	**9**	0	0	0
Surface capping	1	86	**12**	12	0	0
Sheet erosion	1	84	**16**	14	0	2
Fire	2	14	**85**	63	14	8
Grazing/browsing	4	0	**96**	38	35	23
Tree destruction	0	0	**100**	11	16	73
Overall status	**0**	**0**	**100**	**2**	**15**	**83**

Map 16. Observations of surface capping.



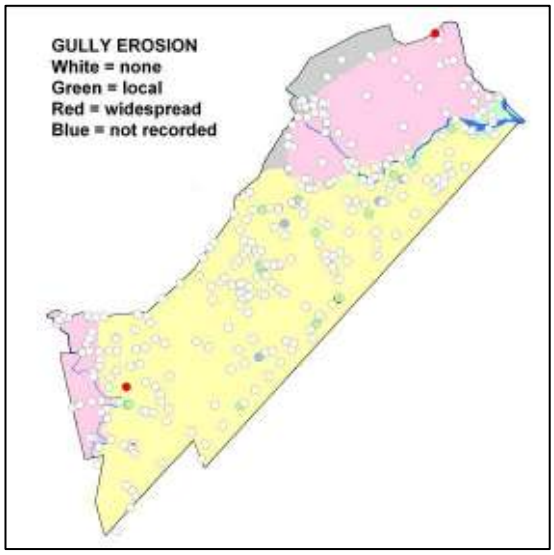
Surface capping was recorded from 41 samples from 14 types/subtypes, of which 9 were various types of mopane woodland (all mopane types and subtypes other than Type 4.4) (Appendix 6, Table 10.6.16). The two types where surface capping was most prevalent were Types 4.5 and 4.6 (54% and 56% of samples, respectively). Additional limited occurrences were noted for Types 1.2, 2.3, 6.1, 7.1 and 9.1. Where surface capping did occur it was almost always rated as local rather than widespread.

Map 17. Observations of sheet erosion.



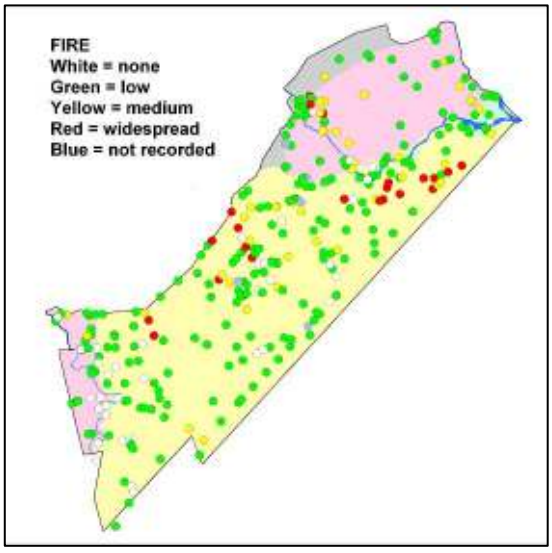
Sheet erosion was recorded from 52 samples from 20 types/subtypes, comprising the same 14 types as for surface capping, plus the six additional Types/Subtypes of 1.1, 6.1.1, 7.2, 8.3, 8.4 and 8.4.1 (Appendix 6, Table 10.6.17). Once again the bulk of the records were from various mopane woodland types (n = 33), but also with three samples from Type 5.1 and four samples from Type 9.1. Again, the occurrence of sheet erosion was mainly local rather than widespread.

Map 18. Observations of gully erosion.



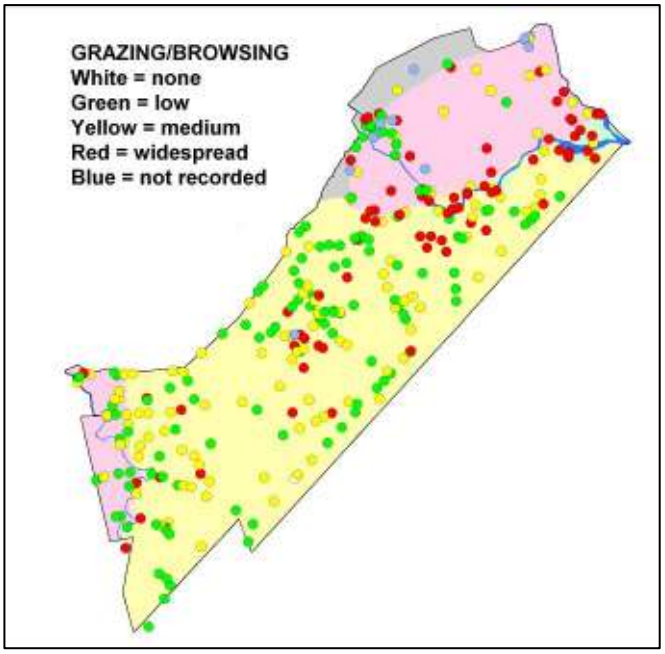
Gully erosion was noted from 19 samples from 10 types/subtypes, comprising Types 4.5, 4.6, 4.6.1, 4.7 and 4.8 mopane woodlands plus Types/Subtypes 2.3, 6.1.1, 8.3, 8.4 and 9.1 (Appendix 6, Table 10.6.18). Four samples were recorded for Subtype 4.6.1 Mopane mixed woodland on Malvernia steep hills and escarpments, one sample each from Type 4.6, Subtype 6.1.1 and Type 9.1, and two samples each from the remaining six types. Where gully erosion did occur it was usually rated as local rather than widespread

Map 19. Observations of signs of burning.



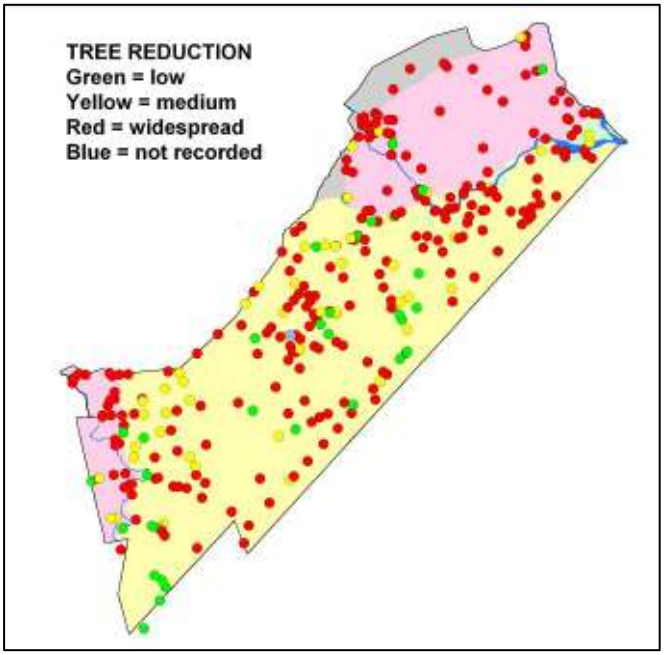
The presence of fire, grazing/browsing and tree reduction were ubiquitous across all vegetation types, being noted from a total of 278, 316 and 329 samples respectively. Types for which fire was rated as medium or high from more than one sample were Types 1.1, 1.2, 1.3, 2.1 and 2.3, all on Malvernia sands, plus mopane woodland Types 4.1, 4.2, 4.6 and 4.6.1 and the three northern granophyre Types 5.1, 7.1 and 8.1 (Appendix 6, Table 10.6.19). All other types were dominated by samples with low or nil signs of burning. Types with a relatively high proportion of samples without evidence of burning included four alluvial or depression types (Types 3.1, 4.8. 4.9 and 9.1), plus Types/Subtypes 1.1.2, 2.3, 4.3, 4.6, 8.2 and 8.2.1 often for samples for which total woody cover was relatively high.

Map 20. Observations of signs of grazing and browsing.



Types for which grazing and browsing were frequently rated as high were Type 9.1 (n= 15 samples), Type 5.1 (n = 10), Type 4.7 (n = 7), Type 4.6 (n = 6), Type 1.2 (n = 5) and Types 4.5, and 4.9 (n = 4 each) (Appendix 6, Table 10.6.20). Other types with low numbers of samples (range = 1 – 8) and for which relatively high proportions of samples were rated as high for evidence of grazing/browsing, were Types 2.2, 4.2, 5.3, 8.4.1 and 11.1. Types with relatively high proportions of samples showing low levels of grazing/browsing were five types on Malvernia sands (Types/Subtypes 1.1, 1.1.1, 1.3, 2.1 and 2.3), four types of mopane woodland (Types/Subtypes 4.3, 4.4, 4.6 and 4.6.1 on marginal soils), two types from the northern granophyre (Types 6.1 and 7.1), most of the *Androstachys johnsonii* types (Types 8.1, 8.2, 8.2.1, 8.3 and 8.4), plus the two special types on steep rhyolite slopes to the south, Types 10.1 and 10.2.

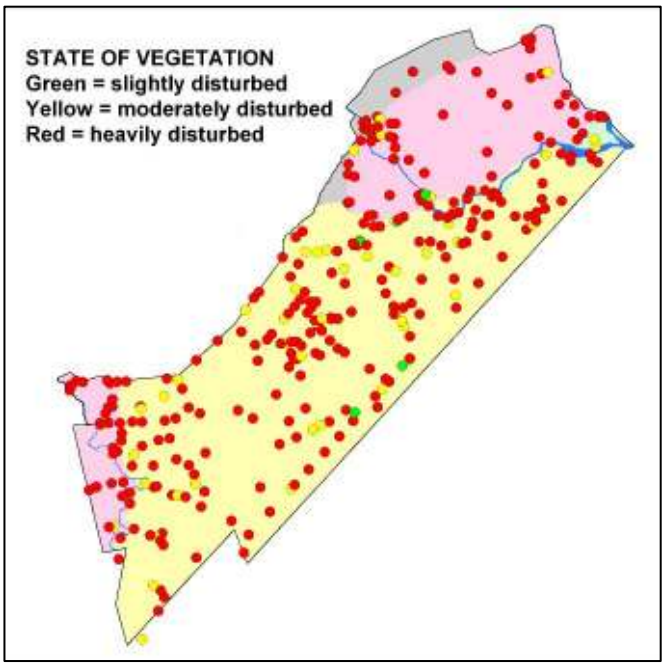
Map 21. Observations of signs of tree reduction.



Concerning the reduction of trees, virtually all types were dominated by samples rated as high, the five exceptions being Type 4.6 (low) and Type/Subtypes 4.3, 6.1.1, 8.3 and 10.2 (medium) (Appendix 6, Table 10.6.21). Types with relatively high numbers or proportions of samples being rated as low or medium were Type 1.2 (n = 11), Type 1.3 (n = 6), Type 2.2 (50%), Type 4.3 (60%), Type 4.6 (n = 17, 68%), Subtype 4.6.1 (n = 5), Type 4.7 (n = 8), Subtype 6.1.1 (100%), Type 8.3 (60%), Type 9.1 (n = 7), and Type 10.2 (100%). No samples were observed without some level of reduction of trees.

The key threat in terms of alien plant species appears to be to the Type 9.1 alluvial woodlands, in terms of both total numbers and occurrences of alien species, and particularly due to the presence of *Lantana camara*, which was recorded from three samples. *Lantana camara* is widely and efficiently spread by birds, such that in the absence of any control measures it can be expected to spread rapidly within the alluvial woodlands and possibly into adjacent types.

Map 22. Overall state of vegetation for 330 samples.



In terms of overall status of the vegetation, 83% of samples were assessed as being highly disturbed (Appendix 6, Table 10.6.22). Those types with relatively high numbers or proportions of samples showing low or moderate disturbance were Type 2.2 (50%), Type 3.1 (n = 5, 63%), Type 4.6 (n = 10), Type 4.7 (n = 6), Type 8.3 (60%), Type 9.1 (n = 6) and Type 10.2 (100%).

7.4 Loss and Reduction of Trees

The evidence for severe degradation of the woody vegetation was readily apparent by the typically low cover of and extensive gaps between canopy trees. Additional evidence came in the form of the frequent presence of large numbers of dead trees, both standing and fallen; the high proportion of remaining canopy trees of virtually all species showing extensive signs of damage to their bark; the fact that many of the remaining trees had been reduced to the level of the subcanopy or even the shrub layer, and that over large areas many of the younger trees were multitrunked from having been burned or knocked down to ground level, probably repeatedly, and then resprouted.

The magnitude of devastation is well illustrated by the following figures relating to the cover of mature top canopy trees within the major vegetation types (Table 17).

In *Guibourtia conjugata* woodland (Types 1.1, 1.1.1 and 1.1.2) in nine out of nineteen stands the cover of the top canopy was below 1%, in seven it was from 1 to 5%, and in two it was between 20 and 40%. In one stand all mature trees had been destroyed.

In secondary mixed Combretaceae woodland (Types 1.2, 1.3 and 5.3) in thirty-six out of seventy-one stands the canopy cover was below 1%, in seven it was from 1 to 5%, in one from 6 to 20% and in twenty-seven stands there was no top canopy left.

In the different types of miombo woodland (Types 2.1, 2.2, 2.3, 5.1, 5.1.1 and 5.2) in twenty-two out of forty-seven stands the canopy cover was below 1%, in nine it was from 1 to 5%, in five from 6 to 20%, in four from 20 to 30%, in three from 40 to 50% and in one from 50 to 60%. In three stands there was no top canopy left.

In *Spirostachys africana* woodland (Types 3.1 and 3.1.1) in three out of nine stands the canopy cover was below 1%, also in three it was 2 to 5% and in another three 6 to 20%.

In *Colophospermum mopane* woodland (Types 4.1 to 4.9) in fifty-seven out of one hundred and ten stands the canopy cover was below 1%, in twenty-six the cover was from 1 to 5%, in thirteen it was from 6 to 20% and in two from 20 to 30%. In twelve stands there were no large canopy trees left.

In *Androstachys johnsonii* woodland (Types 8.1 to 8.4.1) in seventeen out of twenty-four stands the canopy cover was below 1%, in four the cover was 1 to 5%, and in three from 6 to 20%.

Table 17. Cover values of mature canopy trees for broad vegetation types expressed as numbers and percentages of samples.

COUNTS	Types	0	<1%	1-5%	6-20%	20-30%	30-40%	40-50%	50-60%	Total
Guibourtia conjugata woodlands	1.1, 1.1.1, 1.1.2	1	9	7		1	1			19
Secondary mixed Combretaceae woodlands	1.2, 1.3, 5.3	27	36	7	1					71
Miombo woodlands	2.1, 2.2, 2.3, 5.1, 5.1.1, 5.2	3	22	9	5	4		3	1	47
Spirostachys africana woodlands	3.1, 3.1.1		3	3	3					9
Colophospermum mopane woodlands	4.1, 4.1.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.6.1, 4.7, 4.8, 4.8.1, 4.9	12	57	26	13	2				110
Androstachys johnsonii woodlands	8.1, 8.2, 8.2.1, 8.3, 8.4, 8.4.1		17	4	3					24
Mixed woodland on alluvium	9.1		3	5	12	1	1		2	24
Remaining mixed woodland types	6.1, 6.1.1, 7.1, 7.2, 10.1, 10.2, 11.1, 11.2		16	5	3					24
Total		**43**	**163**	**66**	**40**	**8**	**2**	**3**	**3**	**328**
PERCENTAGES	**Types**	**0**	**<1%**	**1-5%**	**6-20%**	**20-30%**	**30-40%**	**40-50%**	**50-60%**	**Total**
Guibourtia conjugata woodlands	1.1, 1.1.1, 1.1.2	5	47	37	0	5	5	0	0	100
Secondary mixed Combretaceae woodlands	1.2, 1.3, 5.3	38	51	10	1	0	0	0	0	100
Miombo woodlands	2.1, 2.2, 2.3, 5.1, 5.1.1, 5.2	6	47	19	11	9	0	6	2	100
Spirostachys africana woodlands	3.1, 3.1.1	0	33	33	33	0	0	0	0	100
Colophospermum mopane woodlands	4.1, 4.1.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.6.1, 4.7, 4.8, 4.8.1, 4.9	11	52	24	12	2	0	0	0	100
Androstachys johnsonii woodlands	8.1, 8.2, 8.2.1, 8.3, 8.4, 8.4.1	0	71	17	13	0	0	0	0	100
Mixed woodland on alluvium	9.1	0	13	21	50	4	4	0	8	100
Remaining mixed woodland types	6.1, 6.1.1, 7.1, 7.2, 10.1, 10.2, 11.1, 11.2	0	67	21	13	0	0	0	0	100
Total		**13**	**50**	**20**	**12**	**2**	**1**	**1**	**1**	**100**

In mixed woodland on alluvium (Type 9.1) in three out of twenty-four stands the canopy cover was below 1%, in five it was from 1 to 5%, in twelve from 6 to 20%, in one each from 20 to 30% and 30 to 40%, and in two stands had a cover of 50 to 60%.

In the remaining various mixed woodland types (Types 6.1, 6.1.1, 7.1, 7.2, 10.1, 10.2, 11.1 and 11.2) in sixteen out of twenty-four stands the canopy cover was less than 1%, in five it was between 1 and 5%, and in three from 6 to 20%.

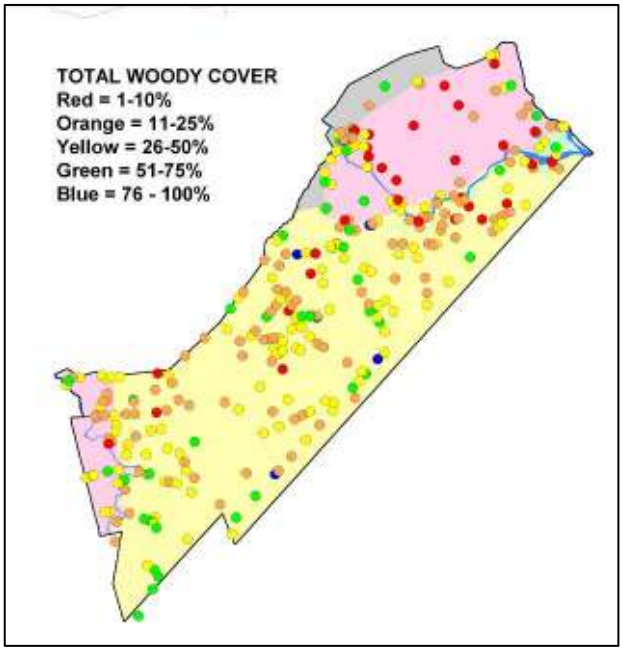
Overall the canopy cover of mature trees was <1% for 63% of all stands, < 5% for 83% and <20% for 95% of all stands.

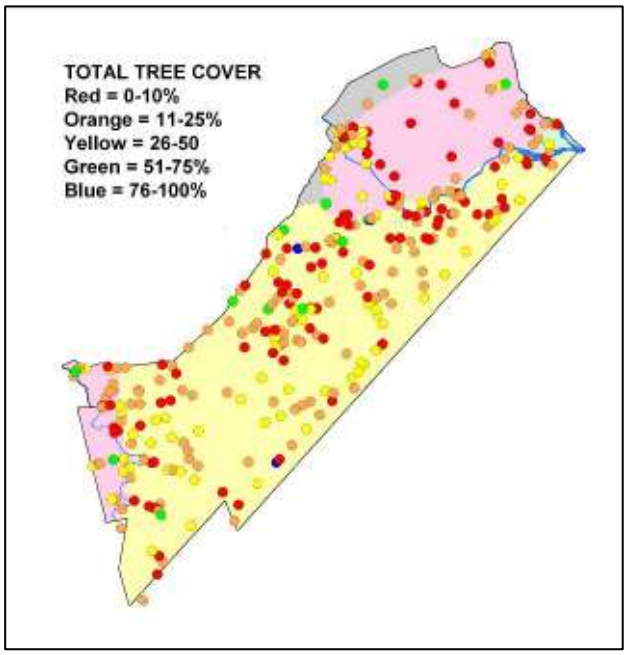
Similarly, in terms of total woody cover, out of all 330 sites sampled 26 stands (8%) had a total woody cover of 3 to 10 %; 82 (25%) a cover of 11 to 20%; 82 (25%) a total cover of 21 to 30%; 54 (16%) a total cover of 31 to 40%; 37 (11%) one of 41 to 50%; 30 (9%) a total cover of 51 to 60%; 12 (4%) a total cover of 61 to 70%; 4 (1%) one of 71 to 80%; and 3 (1%) had a total cover of 90 to 100%. In pristine state the total woody cover could be expected to vary from approximately 70 to 80% in

Colophospermum mopane woodland to about 110 to 130 % in a layered dry forest like what the potential of *Guibourtia conjugata* woodland would be.

These results are in accordance with Tafangenyasha (1997) who, based on the analysis of fixed point photopanoramas, reported a 30.1% decline in tree populations over the 13 year period from 1970 to 1983.

Maps 23 and 24. Total woody cover (%) and total tree cover (%) for the 330 sample points.





Causes of Tree Loss. There are a variety of factors that might have contributed to the observed reduction of the woody vegetation, including: disease, drought, frost, fire, damage by elephants, grazing and browsing by other wildlife (eland, porcupine, etc) or livestock, clearing for cultivation (both past and present), previous clearing for tsestse fly control operations and the development of infrastructure, most likely to varying degrees in different areas. Tafangenyasha (1997) suggested that the main factors influencing the loss of trees were probably elephants, droughts and fire. During the course of this study damage by elephants and fire were observed to be widespread throughout the park and across most vegetation types.

Data on elephant populations within the GNP from 1980 onwards is summarized by Dunham et al. (2010). During the 1980s and up to the time of the severe drought during 1991/92 elephant populations appear to have been kept in check through culling which was carried out in 1983 and 1986, but at a relatively high density fluctuating below and above about 1.0 elephants per km^2. Many animals died during the 1991/92 drought and additional culling (killed and captured) took place in 1992 and 1993. Since then elephant populations have shown a steady increase with the 2009 estimate being roughly double that for 1995. Prior to this, Tafangenyasha (1997) reports elephant densities ranging from 0.9 to 1.2 per km^2 for the period from 1970 to 1974. Thus the GNP has sustained relatively high densities of elephants for a period of over 40 years, and in 2009 the elephant density was nearly 2.0 km^2 (Dunham et al., 2010), which is roughly double the generally accepted threshold of 1.0 elephants per km^2 above which significant tree loss is observed (Martin, Craig and Booth, 1989).

High densities of elephants appear to act in synergy with fire, leading to the progressive conversion of woodland to open woodland or even grassland, as has already occurred over large parts of the Park. As elephants destroy mature canopy trees this creates opportunity for increased herbaceous

production, which leads to more frequent and higher intensity hotter fires, often hotter than what the woody vegetation has evolved to tolerate. The consequence of this is a two pronged attack on the woody vegetation. Trees are pushed over by elephants and trees are burned down by fire. This not only leads to the loss of trees, it also results in the remaining trees being damaged to the extent that many mature large trees have been reduced to the level of the subcanopy or even the shrub layer. Over large areas many of the younger trees were multitrunked from having been burned or knocked down to ground level, probably repeatedly and then resprouted.

Whilst it is difficult to reliably separate out the impacts caused by elephants as opposed to other herbivores, such as eland or cattle, the overall herbivore biomass is strongly dominated by elephants to the extent that they can be expected to have had by far the most significant impacts. However, there are marked incursions of livestock into some of the peripheral areas of the GNP, particularly during times of drought, which can be expected to have additional detrimental impacts to vegetation resources.

Drought is another probable cause of significant losses of trees at least of certain species and within certain portions of the Park. It is possible that severe droughts, such as occurred during the 1991-92 season, have contributed to the loss of Type 5 *Brachystegia tamarindoides* woodlands on the northern granophyre and granite, Type 8 *Androstachys johnsonii* woodlands and Type 3 *Spirostachys africana* woodlands. In some of the *Androstachys johnsonii* woodland stands there were high numbers of standing dead trees, including on steep and rocky slopes. In such cases, although elephant presence was still noted, drought appears a more plausible cause of such tree losses. The same applies to *Spirostachys* woodlands for which large numbers of standing dead trees were commonly observed.

Cultivation results in severe but localized losses of trees as previously occurred prior to the creation of the Park within some of the alluvial communities along the Runde and Save Rivers. More recently, since 2000, a significant part of the Gulugi drainage on the basalt area to the north of the Park has been settled and cultivated, resulting in widespread destruction of the natural vegetation. Development of infrastructure, such as roads and gravel pits, railway lines, airstrips, management camps and tourist facilities similarly result in high impacts to natural vegetation but on a localized scale.

Impacts of Tree Reduction. The results of this study suggest that the vegetation of the GNP has experienced severe degradation over most areas of the Park, with a huge reduction of woody vegetation particularly in the upper canopy layer. Fortunately the topography consists mainly of flat or gently undulating land such that additional soil erosion due to the loss of woody vegetation has remained at tolerable levels, and the stability of the physical environment has not been unduly threatened. Nor is the reduction of tree cover necessarily detrimental to animal communities, as it can often result in an increase in woody vegetation in the lower tree and shrub layers potentially increasing the amount of biomass available to browsers, at least in the short term. If unchecked, in the longer term, this process can be expected to continue unabated until such time as most or all of the woody vegetation has been eliminated, thus removing the food base for certain species.

However, the functioning of the natural ecosystems must have been, and continues to be severely affected, although the extent of this and its ramifications are difficult to grasp let alone estimate. Probably the most serious consequence of this destruction will have been a tremendous loss of biodiversity, as has been demonstrated, for example, for Type 2.3 *Brachystegia tamarindoides* woodland on Malvernia sands. During the intervening 17 year period from 1985 to 2010 there was a notable reduction in the abundance of shrubs and certain species appear to have been completely eliminated (Muller, pers. obs.).

The maintenance of the global diversity, both at the species and ecosystem level, is one of the key aspects of biological conservation. With the expansion of human populations land for nature conservation has become increasingly scarce, and remaining areas available for the maintenance of the biological diversity are mainly under the jurisdiction of national parks, conservation trusts and other similar organizations. In Zimbabwe the primary mandate for biodiversity conservation lies with the Parks and Wildlife Management Authority. To have seen the depletion of biodiversity to the extent that was observed in Gonarezhou National Park is the equivalent of having witnessed a natural disaster, a disaster which has taken place over many years and is still continuing. That this has occurred, and still persists, within a national park is of extreme concern.

Besides the loss of biodiversity and woody cover, the ongoing degradation is destroying some of the most unusual and rarest plant communities found in Zimbabwe, and severely impairing the functioning of the natural ecosystems these communities support.

7.5 Management Actions

Rather than attempting to specify detailed management interventions for specific vegetation types attention is instead drawn to certain key management considerations. Potential management interventions include the implementation of exclusion zones, fire management, management of elephant populations, the control of alien plant species and development of a vegetation monitoring programme.

Exclusion Zones. Given the alarming level of degradation observed over large areas of the GNP, and the likelihood that current trends will be continued, it is strongly recommended that the establishment of exclusion zones should be considered. The purpose of such exclusion zones would specifically be to protect selected areas from further damage by elephants. Ideally the existence of all the vegetation types which occur in the Park should be safeguarded. This might not be feasible, but at least efforts should be made to protect the vegetation which is unique to Gonarezhou. This would entail all the types which occur on the Malvernia Beds, namely Type 1.1 *Guibourtia conjugata* woodland and its two subtypes; Types 1.2 and 1.3 which are types of Combretaceae woodland; Type 2.1 *Brachystegia-Julbernardia* woodland; Type 2.2 *Julbernardia globiflora* woodland; Type 2.3 *Brachystegia tamarindoides* woodland; Type 3.1 *Spirostachys africana* woodland on Malvernia sands; Type 4.5 Mopane woodland on Malvernia heavier textured loam to clay soils; Type 4.6 Mopane woodland on Malvernia pebbly loam soils; Subtype 4.6.1 Mopane mixed woodland on steep hills and escarpments; Type 4.7 Mopane woodland on Malvernia sands; Type 4.8 Mopane - *Spirostachys* woodland along drainage lines; Type 4.8.1 *Androstachys johnsonii* woodland along Malvernia drainage lines; Type 8.3 *Androstachys johnsonii* woodland on Malvernia sands; Type 8.4 *Androstachys johnsonii* woodland on Malvernia escarpments; Type 8.4.1 *Androstachys johnsonii* woodland on Malvernia loam soils; Type 11.1 *Strychnos potatorum* woodland on Malvernia sands; Type 11.2 *Terminalia prunioides* woodland on calcrete. A similar argument applies for the Type 5 and 6 woodlands on the northern igneous rocks. Apart from these, Type 10.1 *Galpinia transvaalica* woodland on south facing rhyolite slopes and Type 10.2 *Lannea schweinfurthii* woodland on north facing rhyolite slopes are both vegetation types with an extremely limited distribution and should also be protected.

Implementation of exclusion blocks is likely to require some level of experimentation to establish options that are efficient, cost effective and potentially sustainable. Before developing any exclusion blocks it will be necessary to carry out a survey to identify those portions where the vegetation is still best preserved, and to examine the feasibility of including multiple vegetation types within a single protected area. The use of exclusion zones should be seen as a temporary stop gap measure, the purpose of which would be to buy time until such a point where elephant populations have been reduced to more sustainable levels. It also provides an immediate management alternative to the far more difficult issue of reducing elephant populations.

Fire Management. The continued destruction of woodland by elephants and fire appears to be the single greatest threat to plant biodiversity within the GNP. Whilst fire management does provide a potential management tool, in the absence of any corresponding controls over elephant numbers, the present reduction of trees is likely to be continued. A key objective of fire management would be to limit the overall detrimental impacts of burning through limiting the occurrence of high intensity fires that are most damaging to woody vegetation.

Management of Elephant Populations. The management of elephant populations is the key determinant to the future status of vegetation resources within the GNP. Enormous degradation of vegetation resources has already occurred and, until such time as elephant densities are substantially reduced, such degradation can be expected to continue. Given the conservation objectives and mandate of the Parks and Wildlife Management Authority and the GNP, and the high conservation importance of many of the constituent plant species and vegetation types, the reduction of elephants is an issue that needs to be addressed as a matter of utmost priority.

Control of Alien Plants. The key habitat of concern as regards the establishment of alien plant species is Type 9.1 mixed woodlands on alluvium, where the greatest variety of alien species was noted, and in particular *Lantana camara* (near Chipinda Pools and in the vicinity of the Save-Runde Junction) which is the key species of concern. *Lantana camara* is an aggressive invader and in the absence of control measures is likely to spread rapidly within the alluvial woodlands and possibly into adjacent communities.

The presence of several alien Cactaceae species was noted in the vicinity of Chipinda Pools and Mabalauta Camps, presumably escaped from gardens. Efforts should also be made to eradicate these species before they become better established.

Monitoring Programme. Aspects potentially important for monitoring include the status of key vegetation communities; population dynamics of key tree plant species, including species of conservation interest; the occurrence of alien plant species; loss of trees; and the status of key threats including elephant populations and the occurrence of fires. The present study provides a good basis for strengthening the existing monitoring programme for the GNP. It provides a means for stratifying monitoring efforts (by vegetation types, by dominant types, types of particular interest, etc), and an indication of key species to monitor (dominant tree species, species of conservation interest, alien plant species etc). The sample data provides potential baseline information which can be revisited in the future, whilst the georeferenced photographs could also provide a useful resource for monitoring purposes.

7.6 Comments on the Methodology

The methodology followed for the study has proved largely satisfactory, although there are always opportunities for refinement and improvement. The field data sheet, for example, although adequate, could certainly have been improved through carrying out an initial field testing exercise. The use of georeferenced high resolution Google imagery as a supplement to Landsat imagery was extremely beneficial, and has added substantially to the quality of the final product. Similarly, the opportunity to carry out a verification trip, although not common practice, proved to be essential. Using the selected methodology has produced results that can readily be compared to, and integrated with, other major studies in Zimbabwe, particularly the survey of communal lands to the north and west of the country (Timberlake, Nobanda and Mapaure, 1993), and the general vegetation classification provided within this work.

Three key issues concern the formidable scale of the study, the challenges imposed by the existing high levels of disturbance, and the implementation of the verification exercise. Other than for the field component the time inputs required for all other aspects of the study were grossly underestimated, in particular concerning the identification of plant species, the development of the electronic data base, the classification of vegetation samples into types and the concurrent mapping of vegetation types. In part this was because the computer based techniques, that were anticipated as being central for classification and mapping purposes, in the event proved to be unsatisfactory and were largely abandoned in favour of much more time consuming manual methods. The complexity and demands of dealing with a database of 330 samples was simply not appreciated and was under estimated.

The high levels of disturbance to the vegetation, in particular, added greatly to the complexity of the study and proved to be a major and unanticipated confounding factor. This disturbance is believed to be at the heart of difficulties regarding classification of samples into types and the mapping of the resulting vegetation types. The extensive reduction of canopy cover and the woody component in general, coupled with subsequent invasion by opportunistic species, in places made it most difficult to ascertain the likely composition of the original vegetation, blurred floristic distinctions between different types and relationships between vegetation types and environmental parameters, and provided different floristic communities with convergent appearances on the satellite imagery.

Given these difficulties the verification exercise proved an essential component of the methodology, adding over 1,000 verified points to aid the mapping exercise. The initial 330 sample points simply proved too few for reliable mapping, such that it was necessary to make substantial changes after the verification exercise, and relating in part to modifications to the classifications of samples into types, including the merging of certain types and the recognition of a number of new types.

7.7 Additional Work

The results of this study should provide a sound framework for planning and management purposes, for example for the management of animal populations, for the development of infrastructure, and the planning of fire management, and environmental monitoring.

However, the study is not by any means exhaustive. For example, for purposes of management of animal populations it would be desirable to have more detailed information on the herbaceous component; with further work it will be possible in places to add further detail, for example for the northern granophyre portion, and to identify additional unique communities similar to those of Types 10 and 11; additional efforts should be made to identify particular areas of conservation interest incorporating much of the overall plant diversity of the GNP; and there is need to make use of the results to strengthen the existing vegetation monitoring programme, including an assessment of how previous photopanorama points relate to the present classification.

To make full use of these results it will be necessary to train some of the Park staff to recognize the different vegetation types in the field and to recognize key plant species, including dominant species, indicator species, species of conservation interest and alien plant species.

8. CONCLUSIONS

In conclusion, the GNP supports a wide diversity of vegetation types, many of which are not represented elsewhere in Zimbabwe or the region. These types include a number of species that are rare or endangered and in some cases that are not found elsewhere in the country. The GNP is thus of high significance for plant conservation in Zimbabwe and the wider region, and this is one of the primary objectives for the GNP as for other national parks in the country.

The vegetation of the GNP has, however, been extensively modified and degraded. This is reflected in major changes to the structure and composition of vegetation types. The most visible impact is the reduction and loss of upper canopy trees and the ongoing conversion of woodland areas to open woodland or grassland. The sample data suggests a much greater impact than initially apparent, or as based on a cursory visual assessment of the vegetation whereby it is easy to consider the current vegetation as the climax type. Despite major modifications to vegetation communities, the stability of the physical environment has not been unduly impaired.

The reduction and loss of trees has principally been caused through impacts by elephants, acting in concert with and providing conditions for more frequent and hotter fires that serve to further reduce the woody vegetation. Continued high densities of elephants represent a critical threat to future conservation of plant biodiversity within the GNP, potentially leading to the loss of certain species and the modification of vegetation types to states from which they may not readily recover. In order for the GNP to fulfill its conservation objectives it is essential that this situation be addressed as a matter of urgency. As a stop gap measure it is recommended that exclusion blocks should be developed. The strengthening of the existing vegetation monitoring programme is also suggested.

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10. APPENDICES

10.1 Data Recording Sheet

B-B scale	**Study Site:**				
r - rare + - occasional 1 - 2-10% cover 2 - 11-25% 3 - 26-50% 4 - 51-75% 5 - 76-100%	**Date:**	**Recorder:**	**Waypoint:**	**Field No.**	**Final No.**
	Co-ordinates	**S**	**E**	**Altitude (m):**	

Woody Species	Mature Trees	>3m	1-3m	<1m	Seedlings	Specimen
Dominant grass species						
Vegetation type						

LANDSCAPE TYPE:

SOIL TYPE		LITHOLOGY		SLOPE		ASPECT		TERMITARIA	
Baserock		Alluvial		Level (0–2º)		North		small (<1m)	
Black clay		Basalt		Gentle (2–10º)		South		medium (1-2m)	
Gravel		Basement		Moderate (10–45º)		West		large (>2m)	
Humus		Granite		Steep (>45º)		East			
Laterite		Quartzite				North West		**Termitaria Density**	
Loam		Rhyolite				North East		None per ha	
Red/pale clay		Sandstone				South West		1-5 per ha	
Sand		Ultrabasics				South East		>5 per ha	

VEGETATION COVER & HEIGHT			
	Cover (%)	**Height (m)**	**Dominant Species**
Tree layer 1			
Tree layer 2			
Total T. cover			
Shrub layer 1			
Shrub layer 2			
Total S. cover			
Total W. Cover			
Grass/Herb			

STATE OF VEGETATION		TYPE OF DISTURBANCE	None	Low	Medium	High	Alien Species	BB
Undisturbed		Tree destruction						
Slightly disturbed		Grazing/Browsing						
Moderately distbd		Fire						
Heavily disturbed								

Bare ground (%)		Litter cover (%)		Surface capping		Erosion			
						Gully		Sheet	
<10		<10		None		None		None	
10-20		10-20		Local		Local		Local	
20-50		>20-50		Widespread		Widespread		Widespread	
>50		>50							

NOTES:

10.2 Details of Vegetation Samples

Coordinates were recorded in decimal degrees using WGS84 datum.

Sample Number	Latitude	Longitude	Altitude (m)	Vegetation Type	Vegetation Field Description
1	-21.2839	31.9235	403	7.1	*Combretum apiculatum* woodland on northern basalts and granophyre
2	-21.2965	31.9377	430	4.2	Mopane woodland on northern granophyre
3	-21.3015	31.9617	405	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
4	-21.4003	32.1571	197	9.1	Mixed woodland on alluvium
5	-21.3961	32.1403	204	4.5	Mopane woodland on northern granophyre
6	-21.3966	32.1130	210	4.2	Mopane woodland on northern granophyre
7	-21.4364	32.0894	201	9.1	Mixed woodland on alluvium
8	-21.2993	31.9548	407	8.1	*Androstachys* woodland on northern granophyre
9	-21.3196	31.9647	315	6.1	Mixed woodland on northern granophyre (clay soils)
10	-21.3413	31.9921	369	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
11	-21.4178	32.0802	209	4.5	Mopane woodland on northern granophyre
12	-21.4072	32.0335	235	0	Mixture of types 5.2 and 6.1
13	-21.2632	31.9301	306	4.1	Mopane woodland on clay
14	-21.2667	31.9338	348	7.1	*Combretum apiculatum* woodland on northern basalts and granophyre
15	-21.2676	31.9357	384	8.1	*Androstachys* woodland on northern granophyre
16	-21.2623	32.3620	179	5.1	Mixture of types 5.2 and 6.1
17	-21.2614	32.3438	221	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
18	-21.3186	31.9654	324	6.1	Mixed woodland on northern granophyre (clay soils)
19	-22.0081	31.4207	294	4.3	Mopane woodland on clay
20	-22.0084	31.4113	323	4.4	*Combretum apiculatum* woodland on southern igneous rocks
21	-21.9413	31.3721	327	4.4	*Combretum apiculatum* woodland on southern igneous rocks
22	-21.9362	31.3848	350	8.2	*Androstachys* woodland on southern igneous rocks
23	-21.9358	31.3869	355	4.3	Mopane woodland on loamy clay
24	-21.9291	31.4159	303	8.2	*Androstachys* woodland on southern igneous rocks
25	-21.9267	31.4389	309	4.3	Mopane woodland on loamy clay
26	-21.8380	31.4351	376	4.7	Mopane woodland on sand with *Combretum apiculatum*
27	-21.8202	31.4315	367	4.3	Mopane woodland on loamy clay
28	-21.7417	31.5444	454	4.8	Mopane - *Spirostachys africana* woodland
29	-21.7575	31.5525	459	1.3	Mixed woodland on Malvernia sands
30	-21.7912	31.5653	447	1.2	Mixed Combretaceae woodland on Malvernia sands
31	-21.8503	31.5071	432	1.2	Mixed Combretaceae woodland on Malvernia sands
32	-21.8612	31.4748	384	4.6	Mopane woodland on shallow sandstone soils
33	-21.7901	31.4169	377	4.1	Mopane woodland on clay
34	-21.7768	31.4167	408	4.4	*Combretum apiculatum* woodland on southern igneous rocks
35	-21.7456	31.3591	435	8.2.1	*Androstachys* woodland on southern igneous rocks
36	-21.7439	31.346	412	7.2	*Combretum apiculatum* woodland on southern igneous rocks
37	-21.8711	31.4264	339	8.2	*Androstachys* woodland on southern igneous rocks
38	-21.8972	31.4555	320	4.6	Mopane woodland on pebbles
39	-21.8781	31.4584	353	4.7	Mopane woodland on sand with *Combretum apiculatum*
40	-21.8110	31.5398	433	4.8	Mopane - *Spirostachys africana* woodland
41	-21.8153	31.5192	456	1.2	*Combretum collinum* woodland with *Guibourtia conjugata* on Malvernia sands
42	-21.8177	31.4744	418	1.2	Mixed Combretaceae woodland on Malvernia sands
43	-21.7897	31.4713	405	4.7	Mopane woodland on sand
44	-21.7936	31.4726	416	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
45	-21.936	31.4983	299	4.8	Mopane - *Spirostachys africana* woodland
46	-21.9342	31.5035	297	4.5	Mopane woodland on loamy clay
47	-21.9500	31.5338	357	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
48	-21.9507	31.5442	368	4.7	Mopane woodland on sand
49	-21.9534	31.5598	381	1.2	Mixed Combretaceae woodland on Malvernia sands
50	-21.9708	31.5904	409	1.2	Mixed Combretaceae woodland on Malvernia sands
51	-21.9291	31.5786	405	4.7	Mopane woodland on sand
52	-21.9124	31.5768	406	1.3	Mixed woodland on Malvernia sands
53	-21.8955	31.5664	406	4.7	Mopane woodland on sand
54	-21.8851	31.5419	359	4.8	Mixed woodland on alluvium
55	-22.2115	31.4769	294	4.6	Mopane woodland on pebbles
56	-22.1597	31.5079	312	4.6	Mopane woodland on shallow sandstone soils
57	-22.0631	31.5813	386	1.2	Mixed Combretaceae woodland on Malvernia sands
58	-21.8025	31.4031	365	4.4	*Combretum apiculatum* woodland on southern igneous rocks with mopane
59	-21.8200	31.3930	337	10.1	Mixed *Galpinia transvaalica* woodland on south facing rhyolite slopes
60	-21.8237	31.3935	352	10.2	Mixed *Lannea schweinfurthii* woodland on north facing rhyolite slopes
61	-22.1352	31.5196	321	4.6	Mopane woodland on pebbles
62	-22.1229	31.5122	329	4.6	Mopane woodland on pebbles
63	-22.1134	31.4971	304	4.7	Mopane woodland on sand with *Combretum apiculatum*
64	-22.0663	31.4305	254	9.1	Mixed woodland on alluvium
65	-22.0278	31.4339	270	7.2	*Combretum apiculatum* woodland on southern igneous rocks
66	-21.8516	31.4343	354	4.3	Mopane woodland on loamy clay
67	-21.8173	31.4557	400	1.2	*Combretum collinum* woodland with *Guibourtia conjugata* on Malvernia sands
68	-21.7704	31.5171	440	4.8	Mopane - *Spirostachys africana* woodland
69	-21.739	31.5226	463	1.3	Mixed woodland on Malvernia sands
70	-21.8471	31.5285	412	1.2	Mixed Combretaceae woodland on Malvernia sands
71	-21.8966	31.4971	366	8.4	*Androstachys* woodland on Malvernia Beds
72	-22.0190	31.5148	362	4.7	Mopane woodland on sand
73	-22.0282	31.5093	357	4.7	Mopane woodland on sand
74	-22.0258	31.5017	338	4.6	Mopane woodland on pebbles
75	-22.023	31.4913	326	4.6	Mopane woodland on pebbles
76	-22.0117	31.4602	285	8.4.1	*Androstachys* woodland on southern igneous rocks
77	-22.0324	31.5116	362	4.7	Mopane woodland on sand
78	-22.0404	31.5168	362	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
79	-21.9433	31.5969	412	1.2	*Combretum apiculatum* woodland with *Guibourtia conjugata* on Malvernia sands

Sample Number	Latitude	Longitude	Altitude (m)	Vegetation Type	Vegetation Field Description
80	-22.0539	31.6740	452	1.1.1	*Guibourtia conjugata* Woodland on Malvernia sands
81	-21.996	31.6496	426	1.3	*Combretum apiculatum* woodland with *Guibourtia conjugata* on Malvernia sands
82	-21.8731	31.5983	430	1.3	Mixed woodland on Malvernia sands
83	-21.9292	31.4814	284	9.1	Mixed woodland on alluvium
84	-21.9464	31.4478	291	7.2	*Combretum apiculatum* woodland on southern igneous rocks
85	-21.9459	31.4515	291	4.6	Mopane woodland on pebbles
86	-21.9522	31.4368	288	8.2	*Androstachys* woodland on southern igneous rocks
87	-21.9654	31.4517	274	8.2	*Androstachys* woodland on southern igneous rocks
88	-21.6426	31.8165	421	1.3	Mixed woodland on Malvernia sands
89	-21.6832	31.8555	420	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
90	-21.7203	31.9176	389	1.2	*Combretum collinum* woodland with *Guibourtia conjugata* on Malvernia sands
91	-21.7429	31.9558	405	1.1.2	*Guibourtia conjugata* Woodland on Malvernia sands
92	-21.6368	31.8126	429	2.3	*Brachystegia tamarindoides* woodland on Malvernia sands
93	-21.6188	31.7960	457	2.3	*Brachystegia tamarindoides* woodland on Malvernia sands
94	-21.5764	31.7728	490	3.1	*Spirostachys africana* woodland in depressions
95	-21.5538	31.7625	512	1.3	Mixed woodland on Malvernia sands
96	-21.5815	31.7016	514	1.3	Mixed woodland on Malvernia sands
97	-21.6774	31.6941	466	1.3	Mixed woodland on Malvernia sands
98	-21.6535	31.6672	501	2.2	*Julbernardia globiflora* woodland on Malvernia sands
99	-21.5919	31.6915	495	4.5	Mopane woodland on loamy clay
100	-21.6136	31.6752	525	2.2	*Julbernardia globiflora* woodland on Malvernia sands
101	-21.7053	31.5797	474	1.2	*Combretum apiculatum* woodland with *Guibourtia conjugata* on Malvernia sands
102	-21.6702	31.6208	524	1.3	Mixed woodland on Malvernia sands
103	-22.0214	31.6834	478	1.1.1	*Guibourtia conjugata* Woodland on Malvernia sands
104	-21.9797	31.7242	488	1.1.1	*Guibourtia conjugata* Woodland on Malvernia sands
105	-21.9376	31.7655	457	8.3	*Androstachys* woodland on Malvernia Beds
106	-21.9308	31.7723	424	4.7	Mopane woodland on sand
107	-21.9353	31.7054	473	1.2	*Combretum apiculatum* woodland with *Guibourtia conjugata* on Malvernia sands
108	-21.9031	31.7995	417	1.2	Mixed Combretaceae woodland on Malvernia sands
109	-21.8712	31.8310	402	1.2	Mixed Combretaceae woodland on Malvernia sands
110	-21.8422	31.8589	427	1.2	Mixed Combretaceae woodland on Malvernia sands
111	-21.8147	31.8861	359	4.5	Mopane woodland on loamy clay
112	-21.7952	31.8718	382	0	Open Combretum woodland
113	-21.8159	31.8391	401	1.2	*Combretum collinum* woodland with *Guibourtia conjugata* on Malvernia sands
114	-21.7058	31.6996	472	1.2	Mixed Combretaceae woodland on Malvernia sands
115	-21.7963	31.6616	474	1.2	*Combretum collinum* woodland with *Guibourtia conjugata* on Malvernia sands
116	-21.8017	31.5871	439	1.2	*Combretum apiculatum* woodland with *Guibourtia conjugata* on Malvernia sands
117	-21.6673	31.7177	458	1.3	Mixed woodland on Malvernia sands
118	-21.8223	31.8233	414	3.1	*Spirostachys africana* woodland in depressions
119	-21.8309	31.8071	421	3.1	*Spirostachys africana* woodland in depressions
120	-21.8447	31.7752	446	1.2	Mixed Combretaceae woodland on Malvernia sands
121	-21.8569	31.7425	444	1.2	Mixed Combretaceae woodland on Malvernia sands
122	-21.8106	31.6905	476	1.3	*Combretum collinum* woodland with *Guibourtia conjugata* on Malvernia sands
123	-21.6575	31.7262	451	1.2	*Combretum collinum* woodland with *Guibourtia conjugata* on Malvernia sands
124	-21.63	31.7506	474	2.2	*Julbernardia globiflora* woodland on Malvernia sands
125	-21.6207	31.7589	463	1.3	Mixed woodland on Malvernia sands
126	-21.6074	31.7708	459	1.3	Mixed woodland on Malvernia sands
127	-21.596	31.7808	468	1.3	Mixed woodland on Malvernia sands
128	-21.5814	31.7906	472	2.3	*Brachystegia tamarindoides* woodland on Malvernia sands
129	-21.5305	31.7778	510	1.3	Mixed woodland on Malvernia sands
130	-21.6688	31.8401	408	4.6	Mopane woodland on shallow sandstone soils
131	-21.6516	31.8237	411	1.2	Mixed Combretaceae woodland on Malvernia sands
132	-21.632	31.8547	412	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
133	-21.6289	31.8546	415	1.2	Mixed Combretaceae woodland on Malvernia sands
134	-21.6277	31.8414	429	2.3	*Brachystegia tamarindoides* woodland on Malvernia sands
135	-21.6302	31.8418	429	1.3	Mixed woodland on Malvernia sands
136	-21.6741	31.7545	410	3.1	*Spirostachys africana* woodland in depressions
137	-21.6331	31.8197	433	2.3	*Brachystegia tamarindoides* woodland on Malvernia sands
138	-21.2853	31.9044	327	4.1	Mopane woodland on clay
139	-21.3066	31.8982	318	7.1	*Combretum apiculatum* woodland on northern basalts and granophyre
140	-21.3249	31.8851	319	7.1	*Combretum apiculatum* woodland on northern basalts and granophyre
141	-21.3719	31.8863	360	7.1	*Combretum apiculatum* woodland on northern basalts and granophyre
142	-21.4193	31.8735	361	4.1	Mopane woodland on clay
143	-21.4185	31.8768	382	7.1	*Combretum apiculatum* woodland on northern basalts and granophyre
144	-21.4561	31.9040	320	4.6	Mopane woodland on shallow sandstone soils
145	-21.4625	31.9239	309	4.6	Mopane woodland on shallow sandstone soils
146	-21.5185	31.7469	481	1.3	Mixed woodland on Malvernia sands
147	-21.5084	31.7916	444	4.6	Mopane woodland on shallow sandstone soils
148	-21.5088	31.8149	479	8.4	*Androstachys* woodland on Malvernia Beds
149	-21.5057	31.8321	412	4.5	Mopane woodland on loamy clay
150	-21.5167	31.9120	330	4.6	Mopane woodland on shallow sandstone soils
151	-21.4884	31.8971	407	4.6.1	Mixed mopane woodland on sandstone hills and escarpments
152	-21.4938	31.8943	472	1.3	Mixed woodland on Malvernia sands
153	-21.4969	31.8924	470	4.6.1	Mixed mopane woodland on sandstone hills and escarpments
154	-21.4896	31.8962	466	4.6.1	Mixture of types 1.1 and 5.6.1
155	-21.4527	31.9655	260	9.1	Mixed woodland on alluvium
156	-21.3381	32.3487	164	9.1	Mixed woodland on alluvium
157	-21.6171	31.9708	312	3.1	Mixed woodland on alluvium
158	-21.6067	31.9637	336	1.3	*Combretum collinum* woodland with *Guibourtia conjugata* on Malvernia sands
159	-21.5589	31.9407	303	4.5	Mopane woodland on loamy clay
160	-21.5357	31.9543	269	4.5	Mopane woodland on loamy clay
161	-21.5430	31.9681	294	4.6	Mopane woodland on shallow sandstone soils
162	-21.4894	32.0131	279	1.2	Mixed Combretaceae woodland on Malvernia sands
163	-21.4891	32.0344	223	4.9	Mopane woodland on alluvium
164	-21.6425	31.9849	334	4.7	Mopane woodland on sand

Sample Number	Latitude	Longitude	Altitude (m)	Vegetation Type	Vegetation Field Description
165	-21.6334	31.9805	334	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
166	-21.6092	31.9823	306	4.7	Mopane woodland on sand
167	-21.6007	31.9983	321	1.2	*Guibourtia conjugata* Woodland on Malvernia sands
168	-21.5574	32.0178	277	1.2	*Guibourtia conjugata* Woodland on Malvernia sands
169	-21.5104	32.0266	239	4.5	Mopane woodland on loamy clay
170	-21.4902	32.1049	357	1.3	Mixed woodland on Malvernia sands
171	-21.4642	32.1137	386	2.1	*Brachystegia-Julbernardia* woodland on Malvernia sands
172	-21.4529	32.1171	382	1.2	*Guibourtia conjugata* Woodland on Malvernia sands
173	-21.4417	32.1435	367	2.1	*Brachystegia-Julbernardia* woodland on Malvernia sands
174	-21.4404	32.1494	369	3.1	*Spirostachys africana* woodland in depressions
175	-21.4428	32.1997	342	2.1	*Brachystegia-Julbernardia* woodland on Malvernia sands
176	-21.4896	32.0885	310	4.6	Mopane woodland on shallow sandstone soils
177	-21.7012	31.9953	382	4.6	Mopane woodland on shallow sandstone soils
178	-21.7034	31.9934	378	4.6	Mopane woodland on shallow sandstone soils
179	-21.7143	31.9809	406	1.1.2	*Guibourtia conjugata* Woodland on Malvernia sands
180	-21.6612	31.9955	345	1.2	*Combretum apiculatum* woodland with *Guibourtia conjugata* on Malvernia sands
181	-21.6206	32.0143	299	4.8	Mopane - *Spirostachys africana* woodland
182	-21.4431	32.0493	201	9.1	Mixed woodland on alluvium
183	-21.4244	32.0309	217	4.9	Mopane woodland on alluvium
184	-21.4030	32.0180	245	8.1	*Androstachys* woodland on northern granophyre
185	-21.4039	32.0197	227	4.2	Mopane woodland on northern granophyre
186	-21.4524	31.9702	255	9.1	Mixed woodland on alluvium
187	-21.3402	31.9628	248	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
188	-21.3395	31.9620	251	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
189	-21.3078	31.9183	288	7.1	*Combretum apiculatum* woodland on northern basalts and granophyre
190	-21.3000	31.9301	396	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
191	-21.1205	32.2287	432	5.2	*Brachystegia tamarindoides* woodland on northern granite
192	-21.1207	32.2269	442	5.2	*Brachystegia tamarindoides* woodland on northern granite
193	-21.1251	32.2277	438	5.3	*Combretum zeyheri* woodland on northern granite
194	-21.1848	32.2494	407	5.3	*Terminalia sericea* woodland on northern granite
195	-21.1253	32.2189	431	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
196	-21.1233	32.2186	395	6.1.1	Mixed woodland on northern granophyre (clay soils)
197	-21.1388	32.2272	478	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
198	-21.2394	32.2843	307	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
199	-21.2759	31.9657	399	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
200	-21.2759	31.9562	406	4.2	Mopane woodland on northern granophyre
201	-21.2815	31.9319	457	8.1	*Androstachys* woodland on northern granophyre
202	-21.1815	31.9994	352	4.1	Mopane woodland on clay
203	-21.3652	32.0226	323	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
204	-21.3705	32.1534	232	4.2	Mopane woodland on northern granophyre
205	-21.3267	32.1446	294	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
206	-21.2413	32.1834	411	6.1	Mixed woodland on northern granophyre (clay soils)
207	-21.1776	32.0727	452	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
208	-21.1714	32.0659	437	7.1	*Combretum apiculatum* woodland on northern basalts and granophyre
209	-21.2197	31.9658	371	4.1	Mopane woodland on clay
210	-21.2902	31.9154	316	8.1	*Androstachys* woodland on northern granophyre
211	-21.2987	32.2450	217	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
212	-21.4382	32.0770	212	9.1	Mixed woodland on alluvium
213	-21.8753	31.4186	327	8.2	*Androstachys* woodland on southern igneous rocks
214	-21.8646	31.4178	335	7.2	*Combretum apiculatum* woodland on southern igneous rocks
215	-21.8218	31.3927	330	3.1.1	*Spirostachys africana* woodland in depressions
216	-21.8196	31.4100	375	4.4	*Combretum apiculatum* woodland on southern igneous rocks with mopane
217	-21.7607	31.3331	363	7.2	*Combretum apiculatum* woodland on southern igneous rocks
218	-21.7515	31.3354	385	4.4	*Combretum apiculatum* woodland on southern igneous rocks with mopane
219	-21.7514	31.3375	404	8.2.1	*Androstachys* woodland on southern igneous rocks
220	-21.7420	31.4064	426	4.1	Mopane woodland on clay
221	-21.7451	31.4258	425	11.2	*Terminalia prunioides* woodland
222	-21.7444	31.4432	421	1.2	*Guibourtia conjugata* Woodland on Malvernia sands
223	-21.7478	31.4118	427	4.4	*Combretum apiculatum* woodland on southern igneous rocks
224	-21.792	31.4084	369	4.1	Mopane woodland on clay
225	-21.6714	31.7753	404	2.2	*Julbernardia globiflora* woodland on Malvernia sands
226	-21.6786	31.7843	396	1.2	*Guibourtia conjugata* Woodland on Malvernia sands
227	-21.6920	31.8118	383	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
228	-21.6959	31.8205	376	4.5	Mopane woodland on loamy clay
229	-21.7990	31.8892	363	4.6	Mopane woodland on shallow sandstone soils
230	-21.7895	31.9333	338	1.3	Mixed Combretaceae woodland on Malvernia sands
231	-21.6553	31.8018	428	1.2	Mixed Combretaceae woodland on Malvernia sands
232	-21.6167	31.8814	389	1.3	Mixed woodland on Malvernia sands
233	-21.5834	31.9483	386	1.3	*Guibourtia conjugata* Woodland on Malvernia sands
234	-21.6209	31.9643	325	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
235	-21.6715	31.7648	413	1.3	Mixed woodland on Malvernia sands
236	-21.6900	31.8686	406	4.6	Mopane woodland on shallow sandstone soils
237	-21.7698	31.9283	360	1.3	Mixed woodland on Malvernia sands
238	-21.7567	31.9426	390	8.3	*Androstachys* woodland on Malvernia Beds
239	-21.7381	31.9484	398	1.1.2	*Guibourtia conjugata* Woodland on Malvernia sands
240	-21.6746	31.7440	436	1.2	Mixed Combretaceae woodland on Malvernia sands
241	-21.6324	31.8102	433	2.3	*Brachystegia tamarindoides* woodland on Malvernia sands
242	-21.4966	32.0561	252	4.7	Mopane woodland on sand
243	-21.5174	32.0648	257	4.7	Mopane woodland on sand
244	-21.5563	32.0810	299	1.3	Mixed Combretaceae woodland on Malvernia sands
245	-21.6089	32.0852	316	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
246	-21.5859	32.0845	296	4.6	Mopane woodland on shallow sandstone soils
247	-21.2862	31.9138	295	9.1	Mixed woodland on alluvium
248	-21.2848	31.9139	302	9.1	Mixed woodland on alluvium
249	-21.2736	31.9030	308	9.1	Mixed woodland on alluvium

Sample Number	Latitude	Longitude	Altitude (m)	Vegetation Type	Vegetation Field Description
250	-21.3494	31.8744	332	4.1	Mopane woodland on clay
251	-21.4941	31.8855	433	4.6.1	Mixed mopane woodland on sandstone hills and escarpments
252	-21.4959	31.8855	475	1.3	Mixed woodland on Malvernia sands
253	-21.4930	31.8837	405	4.6.1	Mixed mopane woodland on sandstone hills and escarpments
254	-21.5069	31.8531	472	1.3	Mixed woodland on Malvernia sands
255	-21.5077	31.8526	450	4.6.1	Mixed mopane woodland on sandstone hills and escarpments
256	-21.4444	31.9826	254	4.5	Mopane woodland on loamy clay
257	-21.4622	31.9361	301	4.2	Mopane woodland on northern granophyre
258	-21.4717	31.7855	411	4.7	Mopane woodland on sand
259	-21.4816	31.7729	423	4.7	Mopane woodland on sand with *Combretum apiculatum*
260	-21.4955	31.9110	429	8.4	Mixed mopane woodland on sandstone hills and escarpments
261	-21.4150	32.0161	239	4.2	Mopane woodland on northern granophyre
262	-21.4055	32.0115	264	8.1	*Androstachys* woodland on northern granophyre
263	-21.4055	31.9547	239	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
264	-21.3676	31.8734	368	7.1	*Combretum apiculatum* woodland on northern basalts and granophyre
265	-21.4568	32.0705	326	4.6.1	Mixed mopane woodland on sandstone hills and escarpments
266	-21.4459	32.0675	200	9.1	Mixed woodland on alluvium
267	-21.4421	31.9228	315	8.1	*Androstachys* woodland on northern granophyre
268	-21.4429	31.9140	301	11.1	*Strychnos potatorum* woodland
269	-21.4495	31.9718	259	9.1	Mixed woodland on alluvium
270	-21.4927	32.0968	353	1.3	Mixed woodland on Malvernia sands
271	-21.4779	32.1441	361	1.2	*Combretum apiculatum* woodland with *Guibourtia conjugata* on Malvernia sands
272	-21.4427	32.2252	331	2.1	*Brachystegia-Julbernardia* woodland on Malvernia sands
273	-21.4354	32.2413	323	2.1	*Brachystegia-Julbernardia* woodland on Malvernia sands
274	-21.4289	32.2574	314	2.1	*Brachystegia-Julbernardia* woodland on Malvernia sands
275	-21.564	32.1286	316	4.5	Mopane woodland on loamy clay
276	-21.5165	32.1745	355	8.3	*Androstachys* woodland on Malvernia Beds
277	-21.4666	32.2220	339	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
278	-21.4575	32.2336	334	2.1	*Brachystegia-Julbernardia* woodland on Malvernia sands
279	-21.4510	32.2405	324	2.1	*Brachystegia-Julbernardia* woodland on Malvernia sands
280	-21.4149	32.2899	299	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
281	-21.4172	32.1724	272	4.6.1	Mixed mopane woodland on sandstone hills and escarpments
282	-21.4076	32.1547	200	9.1	Mixed woodland on alluvium
283	-21.4087	32.1064	189	9.1	Mixed woodland on alluvium
284	-21.4115	32.1065	207	9.1	Mixed woodland on alluvium
285	-21.4043	32.1643	201	9.1	Mixed woodland on alluvium
286	-21.3444	32.3599	233	4.6.1	Mixed mopane woodland on sandstone hills and escarpments
287	-21.3305	32.3454	166	9.1	Mixed woodland on alluvium
288	-21.3430	32.3069	174	4.5	Mopane woodland on northern granophyre
289	-21.4119	32.2517	308	2.1	*Brachystegia-Julbernardia* woodland on Malvernia sands
290	-21.3828	32.2525	250	4.7	Mopane woodland on sand
291	-21.3471	32.2373	209	4.6	Mopane woodland on shallow sandstone soils
292	-21.2743	32.3140	219	4.2	Mopane woodland on northern granophyre
293	-21.2717	32.3108	216	6.1	Mixed woodland on northern granophyre (clay soils)
294	-21.2411	32.3140	284	5.1.1	*Millettia usaramensis* shrubland on northern granophyre (light textured soils)
295	-21.2609	32.3682	173	9.1	Mixed woodland on alluvium
296	-21.2627	32.3708	173	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
297	-21.3333	32.3081	168	9.1	Mixed woodland on alluvium
298	-21.3357	32.3045	181	9.1	Mixed woodland on alluvium
299	-21.3293	32.2883	190	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
300	-21.3312	32.2589	227	4.6.1	Mixed mopane woodland on sandstone hills and escarpments
301	-21.3089	32.268	190	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
302	-21.3165	32.3556	162	9.1	Mixed woodland on alluvium
303	-21.3027	32.3539	165	9.1	Mixed woodland on alluvium
304	-21.2923	32.3301	187	4.7	Mopane woodland on sand
305	-21.3035	32.3197	183	4.9	Mopane woodland on northern granophyre
306	-21.1918	32.2285	428	5.1.1	*Millettia usaramensis* shrubland on northern granophyre (light textured soils)
307	-21.2199	32.1523	432	6.1	Mixed woodland on northern granophyre (clay soils)
308	-21.2591	32.0584	403	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
309	-21.2704	31.9084	301	4.9	Mopane woodland on alluvium
310	-21.6917	31.7643	427	1.1	*Guibourtia conjugata* Woodland on Malvernia sands
311	-21.7025	31.7753	435	8.3	*Androstachys* woodland on Malvernia Beds
312	-21.7032	31.7694	438	1.2	Mixed Combretaceae woodland on Malvernia sands
313	-21.7175	31.7602	439	4.6	Mopane woodland on shallow sandstone soils
314	-21.7672	31.7357	450	1.2	Mixed Combretaceae woodland on Malvernia sands
315	-21.8154	31.7608	441	1.2	Mixed Combretaceae woodland on Malvernia sands
316	-21.7918	31.7928	398	3.1	*Spirostachys africana* woodland in depressions
317	-21.7328	31.7828	406	4.6	Mopane woodland on shallow sandstone soils
318	-21.6972	31.7836	415	4.7	Mopane woodland on sand
319	-21.5992	31.8008	442	1.3	Mixed woodland on Malvernia sands
320	-21.6087	31.8037	444	3.1	*Spirostachys africana* woodland in depressions
321	-21.5989	31.8128	446	2.3	*Brachystegia tamarindoides* woodland on Malvernia sands
322	-21.6292	31.8240	437	8.3	*Androstachys* woodland on Malvernia Beds
323	-21.5465	31.8429	383	4.7	Mopane woodland on sand
324	-21.5653	31.8685	347	4.7	Mopane woodland on sand with *Combretum apiculatum*
325	-21.5389	31.8665	368	4.6	Mopane woodland on shallow sandstone soils
326	-21.4042	32.0251	210	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
327	-21.4314	32.1227	325	4.6.1	Mixed mopane woodland on sandstone hills and escarpments
328	-21.2223	32.2971	322	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)
329	-21.1815	32.2613	376	5.2	*Brachystegia tamarindoides* woodland on northern granite
330	-21.1815	32.1234	502	5.1	*Brachystegia tamarindoides* mixed woodland on northern granophyre (light textured soils)

10.3 List of Woody Plant Species

Species name	Family name	Distribution	New records	IUCN threat status	Introduced
Abrus precatorius L. subsp. africanus Verdc.	FABACEAE				
Acacia ataxacantha DC.	FABACEAE				
Acacia burkei Benth.	FABACEAE	S (confined to GNP)			
Acacia erioloba E.Mey.	FABACEAE				
Acacia erubescens Welw. ex Oliv.	FABACEAE				
Acacia exuvialis I.Verd.	FABACEAE	S (confined to GNP)		Vulnerable	
Acacia galpinii Burtt Davy	FABACEAE				
Acacia gerrardii Benth. subsp. gerrardii var. gerrardii	FABACEAE				
Acacia nigrescens Oliv.	FABACEAE				
Acacia nilotica (L.) Willd. ex Delile subsp. kraussiana (Benth.) Brenan	FABACEAE				
Acacia robusta Burch. subsp. clavigera (E.Mey.) Brenan	FABACEAE				
Acacia schweinfurthii Brenan & Exell var. schweinfurthii	FABACEAE				
Acacia senegal (L.) Willd. var. leiorhachis Brenan	FABACEAE				
Acacia sieberiana DC. var. woodii (Burtt Davy) Keay & Brenan	FABACEAE				
Acacia tortilis (Forssk.) Hayne subsp. heteracantha (Burch.) Brenan	FABACEAE				
Acacia welwitschii Oliv. subsp. delagoensis (Harms) J.H.Ross & Brenan	FABACEAE	SE (GNP/Mahenye)			
Acacia xanthophloea Benth.	FABACEAE				
Acalypha ornata Hochst. ex A.Rich.	EUPHORBIACEAE				
Adansonia digitata L.	BOMBACACEAE				
Adenia fruticosa Burtt Davy subsp. simplicifolia W.J.de Wilde	PASSIFLORACEAE	ES		Vulnerable	
Adenia gummifera (Harv.) Harms	PASSIFLORACEAE				
Adenium multiflorum Klotzsch	APOCYNACEAE	NWES		Endangered	
Afzelia quanzensis Welw.	FABACEAE	NWCES		Lower risk least concern	
Albizia anthelmintica (A.Rich.) Brongn.	FABACEAE				
Albizia brevifolia Schinz	FABACEAE				
Albizia forbesii Benth.	FABACEAE				
Albizia glaberrima (Schumach. & Thonn.) Benth. var. glabrescens (Oliv.) Brenan	FABACEAE				
Albizia harveyi E.Fourn.	FABACEAE				
Albizia petersiana (Bolle) Oliv. subsp. evansii (Burtt Davy) Brenan	FABACEAE				
Albizia versicolor Welw. ex Oliv.	FABACEAE				
Alchornea laxiflora (Benth.) Pax & K.Hoffm.	EUPHORBIACEAE				
Allophylus rubifolius (A.Rich.) Engl. var. rubifolius	SAPINDACEAE				
Ancylobotrys petersiana (Klotzsch) Pierre	APOCYNACEAE				
Androstachys johnsonii Prain	EUPHORBIACEAE				
Anisotes formosissimus (Klotzsch) Milne-Redh.	ACANTHACEAE				
Anisotes rogersii S.Moore	ACANTHACEAE				
Artabotrys brachypetalus Benth.	ANNONACEAE				
Azima tetracantha Lam.	SALVADORACEAE				
Balanites aegyptiaca (L.) Delile var. aegyptiaca	BALANITACEAE				
Balanites maughamii Sprague	BALANITACEAE				
Baphia massaiensis Taub. subsp. obovata (Schinz) Brummitt var. obovata	FABACEAE				
Bauhinia galpinii N.E.Br.	FABACEAE				
Bauhinia tomentosa L.	FABACEAE				
Berchemia discolor (Klotzsch) Hemsl.	RHAMNACEAE				
Bolusanthus speciosus (Bolus) Harms	FABACEAE				
Boscia albitrunca (Burch.) Gilg & Gilg-Ben.	CAPPARACEAE				
Boscia angustifolia A.Rich. var. corymbosa (Gilg) DeWolf	CAPPARACEAE				

Species name	Family name	Distribution	New records	IUCN threat status	Introduced
Boscia foetida Schinz subsp. rehmanniana (Pestal.) Toelken	CAPPARACEAE	S (confined to south)			
Boscia mossambicensis Klotzsch	CAPPARACEAE				
Brachylaena huillensis O.Hoffm.	ASTERACEAE				
Brachystegia spiciformis Benth.	FABACEAE				
Brachystegia tamarindoides Welw. ex Benth. subsp. torrei (Hoyle) Chikuni	FABACEAE				
Brackenridgea zanguebarica Oliv.	OCHNACEAE	ES	New record for south		
Bridelia cathartica G.Bertol.	EUPHORBIACEAE				
Bridelia mollis Hutch.	EUPHORBIACEAE				
Burkea africana Hook.	FABACEAE				
Cadaba termitaria N.E.Br.	CAPPARACEAE				
Canthium glaucum Hiern subsp. frangula (S.Moore) Bridson var. frangula	RUBIACEAE				
Canthium lactescens Hiern	RUBIACEAE				
Canthium racemulosum S.Moore var. racemulosum	RUBIACEAE	ES		Lower risk near threatened	
Canthium setiflorum Hiern subsp. setiflorum	RUBIACEAE				
Capparis sepiaria L. var. subglabra (Oliv.) DeWolf	CAPPARACEAE				
Capparis tomentosa Lam.	CAPPARACEAE				
Carissa bispinosa (L.) Desf. ex Brenan subsp. bispinosa	APOCYNACEAE				
Cassia abbreviata Oliv. subsp. beareana (Holmes) Brenan	FABACEAE				
Catunaregam swynnertonii (S.Moore) Bridson	RUBIACEAE				
Cephalocroton mollis Klotzsch	EUPHORBIACEAE				
Cissus cornifolia (Baker) Planch.	VITACEAE				
Cissus quadrangularis L.	VITACEAE				
Cissus rotundifolia (Forssk.) Vahl var. rotundifolia	VITACEAE				
Citropsis daweana Swingle & Kellerm.	RUTACEAE				
Cladostemon kirkii (Oliv.) Pax & Gilg	CAPPARACEAE				
Cleistanthus schlechteri (Pax) Hutch.	EUPHORBIACEAE				
Cleistochlamys kirkii (Benth.) Oliv.	ANNONACEAE				
Clerodendrum buchneri Gü rke	LAMIACEAE				
Clerodendrum eriophyllum Gü rke	LAMIACEAE				
Clerodendrum pleiosciadium Gü rke	LAMIACEAE	S (confined to GNP)			
Clerodendrum robustum Klotzsch	LAMIACEAE				
Clerodendrum ternatum Schinz var. lanceolatum (G rke) Moldenke	LAMIACEAE				
Clerodendrum wildii Moldenke forma glabrum R.Fern.	LAMIACEAE				
Coffea racemosa Lour.	RUBIACEAE				
Colophospermum mopane (J.Kirk ex Benth.) J.Kirk ex J.Léonard	FABACEAE				
Combretum adenogonium Steud. ex A.Rich.	COMBRETACEAE				
Combretum apiculatum Sond.	COMBRETACEAE				
Combretum celastroides Welw. ex M.A.Lawson subsp. celastroides	COMBRETACEAE				
Combretum collinum Fresen. subsp. collinum	COMBRETACEAE				
Combretum hereroense Schinz var. hereroense	COMBRETACEAE				
Combretum imberbe Wawra	COMBRETACEAE				
Combretum microphyllum Klotzsch	COMBRETACEAE				
Combretum mossambicense (Klotzsch) Engl.	COMBRETACEAE				
Combretum padoides Engl. & Diels	COMBRETACEAE				
Combretum zeyheri Sond.	COMBRETACEAE				
Commiphora africana (A.Rich.) Engl.	BURSERACEAE				
Commiphora caerulea Burtt	BURSERACEAE	NWS	New record for south		
Commiphora edulis (Klotzsch) Engl. subsp. edulis	BURSERACEAE				
Commiphora glandulosa Schinz	BURSERACEAE				
Commiphora marlothii Engl.	BURSERACEAE				

Species name	Family name	Distribution	New records	IUCN threat status	Introduced
Commiphora mollis (Oliv.) Engl.	BURSERACEAE				
Commiphora mossambicensis (Oliv.) Engl.	BURSERACEAE				
Commiphora neglecta I.Verd.	BURSERACEAE	ES (GNP/Chisumbanje)	New record for south	Critically endangered	
Commiphora pyracanthoides Engl.	BURSERACEAE				
Commiphora schlechteri Engl.	BURSERACEAE	S (confined to GNP)	New record for Zimbabwe		
Commiphora zanzibarica (Baill.) Engl.	BURSERACEAE				
Coptosperma littorale (Hiern) Degreef	RUBIACEAE	S (confined to south)			
Coptosperma neurophyllum (S.Moore) Degreef	RUBIACEAE				
Coptosperma zygoon (Bridson) Degreef	RUBIACEAE				
Cordia goetzei Gü rke	BORAGINACEAE				
Cordia grandicalyx Oberm.	BORAGINACEAE				
Cordia monoica Roxb.	BORAGINACEAE				
Cordyla africana Lour.	FABACEAE				
Crossopteryx febrifuga (Afzel. ex G.Don) Benth.	RUBIACEAE				
Croton gratissimus Burch.	EUPHORBIACEAE				
Croton longipedicellatus J.Léonard var. longipedicellatus Radcl.-Sm.	EUPHORBIACEAE				
Croton madandensis S.Moore	EUPHORBIACEAE	ES (GNP/Chisumbanje)		Data deficient	
Croton megalobotrys M ll.Arg.	EUPHORBIACEAE				
Croton menyharthii Pax	EUPHORBIACEAE	NWES	New record for south		
Croton pseudopulchellus Pax	EUPHORBIACEAE				
Croton steenkampianus Gerstner	EUPHORBIACEAE	S (confined to GNP)	New record for Zimbabwe		
Dalbergia arbutifolia Baker subsp. arbutifolia	FABACEAE				
Dalbergia melanoxylon Guill. & Perr.	FABACEAE	NWCES		Lower risk near threatened	
Dalbergia nitidula Baker	FABACEAE				
Deinbollia xanthocarpa (Klotzsch) Radlk.	SAPINDACEAE	NES		Lower risk near threatened	
Dichrostachys cinerea (L.) Wight & Arn. subsp. africana Brenan & Brummitt	FABACEAE				
Diospyros loureiriana G.Don subsp. loureiriana	EBENACEAE				
Diospyros lycioides Desf.	EBENACEAE				
Diospyros mespiliformis Hochst. ex A.DC.	EBENACEAE				
Diospyros squarrosa Klotzsch	EBENACEAE				
Diplorhynchus condylocarpon (M ll.Arg.) Pichon	APOCYNACEAE				
Dombeya kirkii Mast.	STERCULIACEAE				
Dovyalis hispidula Wild	FLACOURTIACEAE				
Drypetes mossambicensis Hutch.	EUPHORBIACEAE				
Drypetes reticulata Pax	EUPHORBIACEAE				
Ehretia amoena Klotzsch	BORAGINACEAE				
Elaeodendron transvaalense (Burtt Davy) R.H.Archer	CELASTRACEAE				
Elephantorrhiza elephantina (Burch.) Skeels	FABACEAE				
Elephantorrhiza goetzei (Harms) Harms subsp. goetzei	FABACEAE				
Entandrophragma caudatum (Sprague) Sprague	MELIACEAE				
Erythrina livingstoneana Baker	FABACEAE				
Erythrococca menyharthii (Pax) Prain	EUPHORBIACEAE	NWCS	New record for south		
Erythrophleum africanum (Welw. ex Benth.) Harms	FABACEAE				
Erythroxylum emarginatum Thonn.	ERYTHROXYLACEAE				
Euclea divinorum Hiern	EBENACEAE				
Euclea natalensis A.DC. subsp. angustifolia F.White	EBENACEAE	S (confined to south)			
Euclea racemosa Murray subsp. schimperi (A.DC.) F.White	EBENACEAE				
Euphorbia cooperi N.E.Br. ex A.Berger var. cooperi	EUPHORBIACEAE				
Euphorbia espinosa Pax	EUPHORBIACEAE				
Euphorbia griseola Pax subsp. griseola	EUPHORBIACEAE	NWCES		Lower risk least concern	

Species name	Family name	Distribution	New records	IUCN threat status	Introduced
Euphorbia ingens E.Mey. ex Boiss.	EUPHORBIACEAE				
Euphorbia tirucalli L.	EUPHORBIACEAE				Exotic
Excoecaria bussei (Pax) Pax	EUPHORBIACEAE				
Faidherbia albida (Delile) A.Chev.	FABACEAE				
Ficus abutilifolia (Miq.) Miq.	MORACEAE				
Ficus bussei Warb. ex Mildbr. & Burret	MORACEAE	NES	New record for south		
Ficus capreifolia Delile	MORACEAE				
Ficus ingens (Miq.) Miq.	MORACEAE				
Ficus sansibarica Warb. subsp. sansibarica	MORACEAE				
Ficus stuhlmannii Warb.	MORACEAE				
Ficus sycomorus L. subsp. sycomorus	MORACEAE				
Ficus tettensis Hutch.	MORACEAE				
Flacourtia indica (Burm.f.) Merr.	FLACOURTIACEAE				
Flueggea virosa (Roxb. ex Willd.) Voigt subsp. virosa	EUPHORBIACEAE				
Friesodielsia obovata (Benth.) Verdc.	ANNONACEAE				
Galpinia transvaalica N.E.Br.	LYTHRACEAE	S (confined to south)			
Garcinia livingstonei T.Anderson	CLUSIACEAE				
Gardenia resiniflua Hiern subsp. resiniflua	RUBIACEAE				
Gardenia sp. c.f. cornuta	RUBIACEAE	S (confined to GNP)	New record for Zimbabwe		
Gardenia volkensii K.Schum. subsp. volkensii var. volkensii	RUBIACEAE				
Gomphocarpus fruticosus (L.) Aiton f. subsp. fruticosus	APOCYNACEAE				
Gossypium herbaceum L. subsp. africanum (Watt) Vollesen	MALVACEAE				
Grewia bicolor Juss.	TILIACEAE				
Grewia caffra Meisn.	TILIACEAE	S (confined to south)			
Grewia flavescens Juss.	TILIACEAE				
Grewia hornbyi Wild	TILIACEAE	S (confined to GNP)			
Grewia inaequilatera Garcke	TILIACEAE				
Grewia lepidopetala Garcke	TILIACEAE				
Grewia micrantha Bojer	TILIACEAE				
Grewia monticola Sond.	TILIACEAE				
Grewia subspathulata N.E.Br.	TILIACEAE				
Grewia sulcata Mast. var. sulcata	TILIACEAE				
Grewia villosa Willd. var. villosa	TILIACEAE				
Guibourtia conjugata (Bolle) J.L,onard	FABACEAE				
Gymnosporia buxifolia (L.) Szyszyl.	CELASTRACEAE				
Gymnosporia maranguensis (Loes.) Loes.	CELASTRACEAE				
Gymnosporia pubescens (N.Robson) Jordaan	CELASTRACEAE				
Gymnosporia putterlickioides Loes.	CELASTRACEAE				
Gymnosporia senegalensis (Lam.) Loes.	CELASTRACEAE				
Gyrocarpus americanus Jacq. subsp. africanus Kubitzki	HERNANDIACEAE				
Heinsia crinita (Afzel.) G.Taylor subsp. parviflora (K.Schum. & K.Krause) Verdc.	RUBIACEAE				
Hexalobus monopetalus (A.Rich.) Engl. & Diels var. monopetalus	ANNONACEAE				
Hippocratea africana (Willd.) Loes. var. richardiana (Cambess.) N.Robson	CELASTRACEAE				
Hippocratea buchananii Loes.	CELASTRACEAE				
Hippocratea crenata (Klotzsch) K.Schum. & Loes.	CELASTRACEAE				
Hippocratea indica Willd.	CELASTRACEAE				
Hippocratea longipetiolata Oliv.	CELASTRACEAE				
Hippocratea parviflora N.E.Br.	CELASTRACEAE	NWS	New record for south		
Holarrhena pubescens (Buch.-Ham.) Wall. ex G.Don	APOCYNACEAE				
Hugonia orientalis Engl.	LINACEAE				

Species name	Family name	Distribution	New records	IUCN threat status	Introduced
Hymenocardia ulmoides Oliv.	EUPHORBIACEAE				
Hymenodictyon parvifolium Oliv. subsp. parvifolium	RUBIACEAE				
Hyphaene petersiana Klotzsch ex Mart.	ARECACEAE				
Jasminum fluminense Vell.	OLEACEAE				
Jasminum stenolobum Rolfe	OLEACEAE				
Jatropha spicata Pax	EUPHORBIACEAE	ES		Data deficient	
Julbernardia globiflora (Benth.) Troupin	FABACEAE				
Kigelia africana (Lam.) Benth.	BIGNONIACEAE				
Kirkia acuminata Oliv.	KIRKIACEAE				
Lagynias dryadum (S.Moore) Robyns	RUBIACEAE				
Landolphia kirkii Dyer ex Hook.f.	APOCYNACEAE				
Lannea schweinfurthii (Engl.) Engl. var. stuhlmannii (Engl.) Kokwaro	ANACARDIACEAE				
Lantana camara L.	VERBENACEAE	NWCES			Exotic
Lantana rugosa Thunb.	VERBENACEAE				
Lecaniodiscus fraxinifolius Baker	SAPINDACEAE				
Leptactina benguelensis (Hook.f.) R.D.Good subsp. pubescens Verdc.	RUBIACEAE				
Leptactina delagoensis K.Schum. subsp. delagoensis	RUBIACEAE	ES (GNP/Hippo mine)		Lower risk least concern	
Maclura africana (Bureau) Corner	MORACEAE				
Maerua angolensis DC.	CAPPARACEAE				
Maerua decumbens (Brongn.) De Wolf	CAPPARACEAE				
Maerua kirkii (Oliv.) F.White	CAPPARACEAE				
Maerua parvifolia Pax	CAPPARACEAE				
Manilkara concolor (Harv.) Gerstner	SAPOTACEAE	S (confined to GNP)		Vulnerable	
Manilkara mochisia (Baker) Dubard	SAPOTACEAE				
Margaritaria discoidea (Baill.) G.L.Webster subsp. nitida (Pax) G.L.Webster	EUPHORBIACEAE				
Markhamia zanzibarica (Bojer ex DC.) K.Schum.	BIGNONIACEAE				
Milicia excelsa (Welw.) C.C.Berg	MORACEAE	ES (GNP/Rusitu valley)		Endangered	
Millettia stuhlmannii Taub.	FABACEAE				
Millettia usaramensis Taub. subsp. australis Gillett	FABACEAE				
Mimusops zeyheri Sond.	SAPOTACEAE				
Monodora junodii Engl. & Diels var. junodii	ANNONACEAE				
Mundulea sericea (Willd.) A.Chev.	FABACEAE				
Mystroxylon aethiopicum (Thunb.) Loes.	CELASTRACEAE				
Neoholstia tenuifolia (Pax) Rauschert var. tenuifolia	EUPHORBIACEAE	NCES	New record for south		
Newtonia hildebrandtii (Vatke) Torre var. pubescens Brenan	FABACEAE				
Ochna barbosae N.Robson	OCHNACEAE				
Ochna inermis (Forssk.) Schweinf.	OCHNACEAE				
Ochna natalitia (Meisn.) Walp.	OCHNACEAE				
Ochna pulchra Hook.f. subsp. pulchra	OCHNACEAE				
Olax dissitiflora Oliv.	OLACACEAE				
Olea europaea L. subsp. cuspidata (Wall. ex G.Don) Cif.	OLEACEAE				
Oncoba spinosa Forssk.	FLACOURTIACEAE	NWCS	New record for south		
Ormocarpum trichocarpum (Taub.) Engl.	FABACEAE				
Ozoroa paniculosa (Sond.) R.& A.Fern. var. paniculosa	ANACARDIACEAE				
Ozoroa reticulata (Baker f.) R.& A.Fern. subsp. reticulata var. crispa R.& A.Fern.	ANACARDIACEAE				
Pachypodium saundersii N.E.Br.	APOCYNACEAE	ES		Vulnerable	
Pappea capensis Eckl. & Zeyh.	SAPINDACEAE				
Pavetta gracillima S.Moore	RUBIACEAE				
Peltophorum africanum Sond.	FABACEAE				
Periploca nigrescens Afzel.	APOCYNACEAE	S (confined to GNP)		Critically endangered	

Species name	Family name	Distribution	New records	IUCN threat status	Introduced
Phileno ptera bussei (Harms) Schrire	FABACEAE				
Phileno ptera violacea (Klotzsch) Schrire	FABACEAE				
Phyllanthus pinnatus (Wight) G.L.Webster	EUPHORBIACEAE				
Phyllanthus reticulatus Poir. var. reticulatus	EUPHORBIACEAE				
Piliostigma thonningii (Schumach.) Milne-Redh.	FABACEAE				
Pluchea dioscoridis (L.) DC.	ASTERACEAE				
Pouzolzia mixta Solms	URTICACEAE				
Pseudolachnostylis maprouneifolia Pax	EUPHORBIACEAE				
Psilotrichum scleranthum Thwaites	AMARANTHACEAE				
Psydrax livida (Hiern) Bridson	RUBIACEAE				
Ptaeroxylon obliquum (Thunb.) Radlk.	PTAEROXYLACEAE				
Pteleopsis anisoptera (Welw. ex M.A.Lawson) Engl. & Diels	COMBRETACEAE	NWCS	New record for south		
Pteleopsis myrtifolia (M.A.Lawson) Engl. & Diels	COMBRETACEAE				
Pterocarpus angolensis DC.	FABACEAE	NWCES		Lower risk near threatened	
Pterocarpus brenanii Barbosa & Torre	FABACEAE				
Pterocarpus lucens Lepr. ex Guill. & Perr. subsp. antunesii (Taub.) Rojo	FABACEAE				
Pterocarpus rotundifolius (Sond.) Druce subsp. rotundifolius	FABACEAE				
Putterlickia verrucosa (E.Mey. ex Sond.) Szyszyl.	CELASTRACEAE	S (confined to GNP)	New record for Zimbabwe		
Rauvolfia caffra Sond.	APOCYNACEAE				
Rhigozum zambesiacum Baker	BIGNONIACEAE				
Rhoicissus revoilii Planch.	VITACEAE				
Rhoicissus tridentata (L.f.) Wild & R.B.Drumm.	VITACEAE				
Rhus gueinzii Sond. var. spinescens (Diels) R.& A.Fern.	ANACARDIACEAE				
Rhus leptodictya Diels	ANACARDIACEAE				
Rinorea elliptica (Oliv.) Kuntze	VIOLACEAE	S (confined to GNP)		Critically endangered	
Rotheca wildii (Moldenke) R.Fern.	LAMIACEAE				
Ruspolia seticalyx (C.B.Clarke) Milne-Redh.	ACANTHACEAE	NWES	New record for south		
Salvadora australis Schweick.	SALVADORACEAE				
Salvadora persica L. var. pubescens Brenan	SALVADORACEAE				
Schotia capitata Bolle	FABACEAE	S (confined to GNP)		Critically endangered	
Schrebera trichoclada Welw.	OLEACEAE				
Sclerocarya birrea (A.Rich.) Hochst. subsp. caffra (Sond.) Kokwaro	ANACARDIACEAE				
Securidaca longepedunculata Fresen.	POLYGALACEAE				
Senna occidentalis (L.) Link	FABACEAE				Exotic
Senna petersiana (Bolle) Lock	FABACEAE				
Senna septemtrionalis (Viv.) Irwin & Barneby	FABACEAE				Exotic
Sideroxylon inerme L. subsp. diospyroides (Baker) J.H.Hemsl.	SAPOTACEAE	S (confined to south)			
Spirostachys africana Sond.	EUPHORBIACEAE				
Stadmannia oppositifolia (Lam.) Poir. subsp. rhodesica Exell	SAPINDACEAE	ES		Lower risk near threatened	
Steganotaenia araliacea Hochst. var. araliacea	APIACEAE				
Sterculia rogersii N.E.Br.	STERCULIACEAE				
Strophanthus kombe Oliv.	APOCYNACEAE				
Strychnos decussata (Pappe) Gilg	STRYCHNACEAE				
Strychnos henningsii Gilg	STRYCHNACEAE				
Strychnos lucens Baker	STRYCHNACEAE				
Strychnos madagascariensis Poir.	STRYCHNACEAE				
Strychnos potatorum L.f.	STRYCHNACEAE				
Strychnos spinosa Lam.	STRYCHNACEAE				
Suregada zanzibariensis Baill.	EUPHORBIACEAE	S (confined to GNP)		Vulnerable	
Synaptolepis alternifolia Oliv.	THYMELAEACEAE				

Species name	Family name	Distribution	New records	IUCN threat status	Introduced
Tabernaemontana elegans Stapf	APOCYNACEAE				
Terminalia prunioides M.A.Lawson	COMBRETACEAE				
Terminalia sericea Burch. ex DC.	COMBRETACEAE				
Terminalia stenostachya Engl. & Diels	COMBRETACEAE				
Thilachium africanum Lour.	CAPPARACEAE				
Tiliacora funifera (Miers) Oliv.	MENISPERMACEAE				
Tinnea rhodesiana S.Moore	LAMIACEAE				
Tinnea zambesiaca Baker	LAMIACEAE				
Tricalysia allenii (Stapf) Brenan	RUBIACEAE				
Tricalysia jasminiflora (Klotzsch) Benth. var. jasminiflora	RUBIACEAE				
Tricalysia junodii (Schinz) Brenan	RUBIACEAE				
Trichilia emetica Vahl subsp. emetica	MELIACEAE				
Turraea obtusifolia Hochst.	MELIACEAE				
Tylosema fassoglense (Schweinf.) Torre & Hillc.	FABACEAE				
Uvaria gracilipes N.Robson	ANNONACEAE	ES (GNP/Mahenye)		Lower risk near threatened	
Vangueria infausta Burch. subsp. infausta	RUBIACEAE				
Vangueria randii S.Moore subsp. randii	RUBIACEAE				
Vepris bremekampii (I.Verd.) W.Mziray	RUTACEAE				
Vepris myrei (Exell & Mendonca) W.Mziray	RUTACEAE				
Vepris reflexa I.Verd.	RUTACEAE				
Vepris trichocarpa (Engl.) W.Mziray	RUTACEAE				
Vepris zambesiaca S.Moore	RUTACEAE				
Vitex ferruginea Schumach. & Thonn. subsp. amboniensis (Gürke) Verdc.	LAMIACEAE	ES			
Vitex mombassae Vatke	LAMIACEAE				
Vitex patula E.A.Bruce	LAMIACEAE				
Vitex payos (Lour.) Merr. var. payos	LAMIACEAE				
Withania somnifera (L.) Dunal	SOLANACEAE				Exotic
Wrightia natalensis Stapf	APOCYNACEAE	ES (GNP/Chisumbanje)		Lower risk least concern	
Xanthocercis zambesiaca (Baker) Dumaz-le-Grand	FABACEAE				
Xeroderris stuhlmannii (Taub.) Mendon‡a & E.C.Sousa	FABACEAE				
Ximenia americana L. var. microphylla Welw. ex Oliv.	OLACACEAE				
Ximenia caffra Sond.	OLACACEAE				
Xylia torreana Brenan	FABACEAE				
Zanthoxylum humile (E.A.Bruce) P.G.Waterman	RUTACEAE				
Ziziphus mucronata Willd.	RHAMNACEAE				
Ziziphus pubescens Oliv.	RHAMNACEAE				

10.4 List of Herbaceous Plant Species

Species name	Family name	Distribution	IUCN threat status	New records	Introduced
Abutilon angulatum (Guill. & Perr.) Mast. var. angulatum	MALVACEAE				
Abutilon grandiflorum G.Don	MALVACEAE				
Acalypha fimbriata Schumach. & Thonn.	EUPHORBIACEAE				
Acanthospermum hispidum DC.	ASTERACEAE				Exotic
Actiniopteris dimorpha Pic.Serm. subsp. dimorpha	PTERIDACEAE				
Alternanthera pungens Kunth	AMARANTHACEAE				Exotic
Ammannia prieuriana Guill. & Perr.	LYTHRACEAE				
Andropogon contortus L.	POACEAE				
Andropogon fastigiatus Sw.	POACEAE				
Andropogon gayanus Kunth	POACEAE				
Aptosimum lineare Marloth & Engl.	SCROPHULARIACEAE				
Aristida adscensionis L.	POACEAE				
Aristida congesta Roem. & Schult.	POACEAE				
Aristida meridionalis Henrard	POACEAE				
Aristida mollissima Pilg.	POACEAE				
Aristida rhiniochloa Hochst.	POACEAE				
Aristida scabrivalvis Hack. subsp. scabrivalvis	POACEAE				
Aristida stipitata Hack.	POACEAE				
Asparagus africanus Lam.	ASPARAGACEAE				
Asparagus plumosus Baker	ASPARAGACEAE				
Asparagus schroederi Engl.	ASPARAGACEAE				
Asparagus suaveolens Burch.	ASPARAGACEAE				
Aspilia mossambicensis (Oliv.) Wild	ASTERACEAE				
Barleria affinis C.B.Clarke	ACANTHACEAE				
Barleria aromatica Oberm.	ACANTHACEAE	NWCES Near Endemic	Data Deficient		
Barleria elegans S.Moore ex C.B.Clarke	ACANTHACEAE	ES (S plus Mahenye)			
Barleria heterotricha Lindau	ACANTHACEAE				
Barleria lancifolia T.Anderson subsp. lancifolia	ACANTHACEAE				
Barleria senensis Klotzsch	ACANTHACEAE				
Barleria spinulosa Klotzsch	ACANTHACEAE				
Basananthe pedata (Baker f.) W.J.de Wilde	PASSIFLORACEAE				
Bidens pilosa L.	ASTERACEAE				
Blainvillea gayana Cass.	ASTERACEAE				
Blepharis aspera Oberm.	ACANTHACEAE				
Blepharis diversispina (Nees) C.B.Clarke	ACANTHACEAE				
Blepharis pungens Klotzsch	ACANTHACEAE				
Bothriochloa insculpta (Hochst. ex A.Rich.) A.Camus	POACEAE				
Bothriochloa radicans (Lehm.) A.Camus	POACEAE				
Brachiaria brizantha (A.Rich.) Stapf	POACEAE				
Brachiaria deflexa (Schumach.) C.E.Hubb. ex Robyns	POACEAE				
Bulbostylis burchellii (Ficalho & Hiern) C.B.Clarke	CYPERACEAE				
Calostephane divaricata Benth.	ASTERACEAE				
Celosia trigyna L.	AMARANTHACEAE				
Centemopsis kirkii (Hook.f.) Schinz	AMARANTHACEAE				
Ceratotheca sesamoides Endl.	PEDALIACEAE				
Chamaecrista absus (L.) Irwin & Barneby	FABACEAE				
Cheilanthes viridis (Forssk.) Sw.	PTERIDACEAE				
Chloris virgata Sw.	POACEAE				

Species name	Family name	Distribution	IUCN threat status	New records	Introduced
Chrysopogon serrulatus Trin.	POACEAE				
Cleome monophylla L.	CAPPARACEAE				
Corchorus trilocularis L.	TILIACEAE				Exotic
Crotalaria gazensis Baker f.	FABACEAE				
Crotalaria podocarpa DC.	FABACEAE				
Crotalaria virgulata Klotzsch	FABACEAE				
Cymbopogon caesius (Hook. & Arn.) Stapf	POACEAE				
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy	POACEAE				
Cynodon dactylon (L.) Pers.	POACEAE				
Dactyloctenium giganteum Fisher & Schweick.	POACEAE				
Danthoniopsis dinteri (Pilg.) C.E.Hubb.	POACEAE				
Datura stramonium L.	SOLANACEAE				Exotic
Dicerocaryum senecioides (Klotzsch) Abels	PEDALIACEAE				
Dicoma tomentosa Cass.	ASTERACEAE				
Digitaria eriantha Steud.	POACEAE				
Digitaria milanjiana (Rendle) Stapf	POACEAE				
Echinochloa colona (L.) Link	POACEAE				
Endostemon tenuiflorus (Benth.) M.Ashby	LAMIACEAE				
Enneapogon cenchroides (Licht. ex Roem. & Schult.) C.E.Hubb.	POACEAE				
Enneapogon scoparius Stapf	POACEAE				
Enteropogon macrostachyus (Hochst. ex A.Rich.) Munro ex Benth.	POACEAE				
Eragrostis aspera (Jacq.) Nees	POACEAE				
Eragrostis curvula (Schrad.) Nees	POACEAE				
Eragrostis cylindriflora Hochst.	POACEAE				
Eragrostis lappula Nees	POACEAE				
Eragrostis lehmanniana Nees var. chaunantha (Pilg.) De Winter	POACEAE				
Eragrostis pallens Hack.	POACEAE				
Eragrostis superba Peyr.	POACEAE				
Eragrostis trichophora Coss. & Durieu	POACEAE				
Eragrostis viscosa (Retz.) Trin.	POACEAE				
Euphorbia heterophylla L.	EUPHORBIACEAE				Exotic
Evolvulus alsinoides (L.) L.	CONVOLVULACEAE				
Gnidia chrysantha (Solms) Gilg	THYMELAEACEAE				
Harpagophytum zeyheri Decne. subsp. sublobatum (Engl.) Ihlenf. & H.E.K.Hartmann	PEDALIACEAE				
Heliotropium ciliatum Kaplan	BORAGINACEAE				
Heliotropium ovalifolium Forssk.	BORAGINACEAE				
Hemizygia bracteosa (Benth.) Briq.	LAMIACEAE				
Hemizygia petrensis (Hiern) M.Ashby	LAMIACEAE				
Hermannia kirkii Mast.	STERCULIACEAE				
Heteropogon contortus (L.) Roem. & Schult.	POACEAE				
Heteropogon melanocarpus (Elliott) Benth.	POACEAE				
Hibiscus caesius Garcke var. caesius	MALVACEAE				
Hibiscus engleri K.Schum.	MALVACEAE				
Hibiscus micranthus L.f.	MALVACEAE				
Hibiscus panduriformis Burm.f.	MALVACEAE				
Hibiscus seineri Engl.	MALVACEAE				
Hyparrhenia rufa (Nees) Stapf	POACEAE				
Hypoestes forskaolii (Vahl) R.Br.	ACANTHACEAE				
Indigofera costata Guill. & Perr. subsp. macra (E.Mey.) J.B.Gillett	FABACEAE				
Indigofera flavicans Baker	FABACEAE				

Species name	Family name	Distribution	IUCN threat status	New records	Introduced
Indigofera praticola Baker f.	FABACEAE				
Indigofera schimperi Jaub. & Spach	FABACEAE				
Indigofera setiflora Baker	FABACEAE				
Justicia matammensis (Schweinf.) Oliv.	ACANTHACEAE				
Kyllinga alba Nees	CYPERACEAE				
Kyphocarpa angustifolia (Moq.) Lopr.	AMARANTHACEAE				
Lepidagathis scabra C.B.Clarke	ACANTHACEAE				
Limeum argute-carinatum Wawra ex Wawra & Peyr.	MOLLUGINACEAE	S (confined to south)			
Lippia javanica (Burm.f.) Spreng.	VERBENACEAE				
Melhania acuminata Mast.	STERCULIACEAE				
Melhania forbesii Planch. ex Mast.	STERCULIACEAE				
Melhania randii Baker f.	STERCULIACEAE				
Melinis repens (Willd.) Zizka	POACEAE				
Merremia kentrocaulos (C.B.Clarke) Hallier f.	CONVOLVULACEAE				
Merremia pinnata (Hochst. ex Choisy) Hallier f.	CONVOLVULACEAE				
Mimosa pigra L.	FABACEAE				
Monechma debile (Forssk.) Nees	ACANTHACEAE				
Ocimum americanum L. var. americanum	LAMIACEAE				Exotic
Oropetium capense Stapf	POACEAE				
Panicum coloratum L. var. coloratum	POACEAE				
Panicum maximum Jacq.	POACEAE				
Perotis patens Gand.	POACEAE				
Phyllanthus maderaspatensis L.	EUPHORBIACEAE				
Pogonarthria squarrosa (Roem. & Schult.) Pilg.	POACEAE				
Sacciolepis curvata (L.) Chase	POACEAE				
Schmidtia pappophoroides Steud.	POACEAE				
Schoenoplectus senegalensis (Steud.) J.Raynal	CYPERACEAE				
Seddera suffruticosa (Schinz) Hallier f.	CONVOLVULACEAE				
Sehima ischaemoides Forssk.	POACEAE				
Sesbania rostrata Bremek. & Oberm.	FABACEAE				
Setaria sagittifolia (A.Rich.) Walp.	POACEAE				
Sida cordifolia L.	MALVACEAE				Exotic
Sida hoepfneri Gü rke	MALVACEAE				
Sida ovata Forssk.	MALVACEAE				
Solanum incanum L.	SOLANACEAE				
Sorghum halepense (L.) Pers.	POACEAE				Exotic
Sorghum versicolor Andersson	POACEAE				
Sphaeranthus peduncularis DC. subsp. peduncularis	ASTERACEAE				
Sphedamnocarpus pruriens (A.Juss.) Szyszyl. var. pruriens	MALPIGHIACEAE				
Sphenostylis erecta (Baker.f.) Hutch. ex Baker.f.	FABACEAE				
Sporobolus festivus Hochst. ex A.Rich.	POACEAE				
Sporobolus panicoides A.Rich.	POACEAE				
Stipagrostis hirtigluma (Steud. ex Trin. & Rupr.) De Winter subsp. patula (Hack.) De Winter	POACEAE				
Tephrosia euchroa I.Verd.	FABACEAE				
Tephrosia noctiflora Bojer ex Baker	FABACEAE				
Tephrosia purpurea (L.) Pers. subsp. leptostachya (DC.)	FABACEAE				
Tephrosia rhodesica Baker f. var. rhodesica	FABACEAE				
Tephrosia villosa (L.) Pers. subsp. ehrenbergiana (Schweinf.) Brummitt	FABACEAE				
Tetrapogon tenellus (Roxb.) Chiov.	POACEAE				

Species name	Family name	Distribution	IUCN threat status	New records	Introduced
Tragia okanyua Pax	EUPHORBIACEAE				
Tragus berteronianus Schult.	POACEAE				
Tricliceras glanduliferum (Klotzsch) R.Fern.	TURNERACEAE				
Tricliceras tanacetifolium (Klotzsch) R.Fern.	TURNERACEAE				
Triumfetta pentandra A.Rich.	TILIACEAE				
Triumfetta rhomboidea Jacq.	TILIACEAE				
Urochloa mosambicensis (Hack.) Dandy	POACEAE				
Vernonia fastigiata Oliv. & Hiern	ASTERACEAE				
Vernonia poskeana Vatke & Hildebr.	ASTERACEAE				
Waltheria indica L.	STERCULIACEAE				
Xanthium strumarium L.	ASTERACEAE				Exotic
Xerophyta equisetoides Baker var. equisetoides	VELLOZIACEAE				
Zornia glochidiata DC.	FABACEAE				

10.5 Woody Plant Species by Vegetation Types.

Species names	0	1.1	1.1.1	1.1.2	1.2	1.3	2.1	2.2	2.3	3.1	3.1.1	4.1	4.2	4.3	4.4	4.5	4.6	4.6.1	4.7	4.8	4.9	5.1	5.1.1	5.2	5.3	6.1	6.1.1	7.1	7.2	8.1	8.2	8.2.1	8.3	8.4	8.4.1	9.1	10.1	10.2	11.1	11.2	Total
Abrus precatorius subsp. africanus										1																														1
Acacia ataxacantha		2		2	7	1			2	2								2														1								19
Acacia burkei		3			4	4	1	2	2	1									1			2																		20
Acacia erioloba						2			1																															3
Acacia erubescens	1					1							3	1	2		1					9				4	1	2	4	6	4			1			1			41
Acacia exuvialis																	18	8															1							27
Acacia galpinii																										1	1								3					5
Acacia gerrardii subsp. gerrardii var. gerrardii						1				1							1									1														4
Acacia nigrescens	1	3			6	3	1			3		4	4	3	2	6	9	5	5	1	2	8				3		6	3	1	1			1	1	8	1	1			92
Acacia nilotica subsp. kraussiana		1			1	2			1	6				1		1	1	1	2																	1					18
Acacia robusta subsp. clavigera																				1						1	1									9					12
Acacia schweinfurthii var. schweinfurthii				1																		1														8					10
Acacia senegal var. leiorhachis						1											4	7															1							13
Acacia sieberiana var. woodii																																			2					2
Acacia tortilis subsp. heteracantha		1				1				1						1				1	2								2		1				1	19					30
Acacia welwitschii subsp. delagoensis	1	2			6								3									5				3							1			3					24
Acacia xanthophloea																																			2					2
Acalypha ornata																					1														4					5
Adansonia digitata	1	2			1							1	2			1		1	1		1	9		1		2		3	1	3			1			10		1			42
Adenia fruticosa subsp. simplicifolia																						1							2			1								4
Adenia gummifera																																	1							1
Adenium multiflorum													1					1				4							1						1					8
Afzelia quanzensis				1	3			1	1						1				1			5					1		1	3	2			1	1				22
Albizia anthelmintica	1									1			1			1	2	1		1														1					9
Albizia brevifolia						2							1					4				1					2		1	3									14
Albizia forbesii		1			2	1	1		2	1																													8
Albizia glaberrima var. glabrescens																																			2					2
Albizia harveyi	1					3				2					1	1	2	1									1	1							6					19
Albizia petersiana subsp. evansii		2			3	1											1		3																					10
Albizia versicolor																																			1					1
Alchornea laxiflora		2	1	1	1		1		2	1		1						1		1		12	1	2					1	1		2			4					35
Allophylus rubifolius var. rubifolius					1						1			1	1					1						1	1								6	1				14
Ancylobotrys petersiana					4	2	2		1																										9					9
Androstachys johnsonii	1	1			2		1		1				1					8	1	1		9		1		1		1	2	7	6	2	5	3	1					55
Anisotes formosissimus																												1							1					2
Anisotes rogersii																1		1				6						2												10
Artabotrys brachypetalus		1			5	4	7	3	3	2												14		3				1	1	4	1	1				2				52
Azima tetracantha																																			3					3
Balanites aegyptiaca var. aegyptiaca									2	1							4	1		1																				9
Balanites maughamii		3	3		3		2		1									1	1	1		4		1												4					24
Baphia massaiensis subsp. obovata var. obovata			3	1	3	2																																		9
Bauhinia galpinii																				1																					1
Bauhinia tomentosa										1						1						7		1		2		1		1						5					19
Berchemia discolor		1			9					5		2	2			1	1	5	4	5		7	1	1		2	1	2	1	3	3		1	1		15		1		1	75
Bolusanthus speciosus										2						1	9	5																							17
Boscia albitrunca		7		1	7		4		4	2		1		1	1	1	1	1	5			2											2								40
Boscia angustifolia var. corymbosa	1	2		1	3	2	1	1		2		1	5	1	2		3	1	7			18	2	3		4		7	4	5	3	2			1		1				83
Boscia foetida subsp. rehmanniana	1	3	2	1	12	2	3	1	3	4				2		1	1	1	3	4		1							1		3		1	1							51

Species names	0	1.1	1.1.1	1.1.2	1.2	1.3	2.1	2.2	2.3	3.1	3.1.1	4.1	4.2	4.3	4.4	4.5	4.6	4.6.1	4.7	4.8	4.9	5.1	5.1.1	5.2	5.3	6.1	6.1.1	7.1	7.2	8.1	8.2	8.2.1	8.3	8.4	8.4.1	9.1	10.1	10.2	11.1	11.2	Total
Boscia mossambicensis		1														1			1													1			13					17
Brachylaena huillensis		1	2	1	2				1														1									1								9
Brachystegia spiciformis							5																																	5
Brachystegia tamarindoides subsp. torrei							5		7	1												19		3					4			1								40
Brackenridgea zanguebarica					1																																		1
Bridelia cathartica																					1	1				1									4					7
Bridelia mollis													1		1							4		1		1		1	1	3	1									14
Burkea africana					3	18	2	1										1						1	1															27
Cadaba termitaria																	1																							1
Canthium glaucum subsp. frangula var. frangula	1			1	1	1	1		2				2					3	1			15		2		1		4	5	4	6		2			2	1			1	56
Canthium lactescens																						1																		1
Canthium racemulosum var. racemulosum																						4		1		1			2											8
Canthium setiflorum subsp. setiflorum	1	2						1	1	2			1				1	2				2		1				1		4	1			2						22
Capparis sepiaria var. subglabra																				1															16			1		18
Capparis tomentosa									1	4			2	1		2				2		8	2	1		3	1		1		4	1		1			21		1	1		57
Carissa bispinosa subsp. bispinosa					1																																			1
Cassia abbreviata subsp. beareana	2	10	2	2	27	7	4	1	1	4		4	6	1	4	4	7	6	15	5	1	17	1	1		5		5	5	7	5	1	4	1	1	7	1	1	1		176
Catunaregam swynnertonii		1			10	14	3	2		3							1	1	6	1		2			1											5					50
Cephalocroton mollis																				1							1									1					3
Cissus cornifolia	2	4			20	12	1	1		5		6	5	2	4	8	12	4	15	3	1	6			1	3	1	7	1	1				1			1			127
Cissus quadrangularis														1				2												1										4
Cissus rotundifolia var. rotundifolia																		2																						2
Citropsis daweana		1																				1	1	1											2					6
Cladostemon kirkii																						2	1	2											2			1		8
Cleistanthus schlechteri							1		2													4		2			1		1											11
Cleistochlamys kirkii		1			3	1			2	5			2			4	1		6	1	2	7	1		1	3		1		3	1				16			1		62
Clerodendrum buchneri					1	2	1		4																															8
Clerodendrum eriophyllum						2		1											1	1															1					6
Clerodendrum pleiosciadium		2	3	1	5																																			11
Clerodendrum robustum					2	5	4	4		1												1																		17
Clerodendrum ternatum var. lanceolatum					1										1				2																					4
Clerodendrum wildii	1																					1																		2
Coffea racemosa		4			12	1	4		4	2	1				2				6	2	1	10	1	2				1							4	1				58
Colophospermum mopane	1	5			10	5	1			5	1	9	8	5	7	13	25	11	22	6	4	10				1	1	7	5	2	4	1	2	3	1	11	1	1		1	189
Combretum adenogonium																									1	2														3
Combretum apiculatum	2	10			33	18	3	1		4		8	6	4	7	7	17	9	21	3	2	13		2	1	2		9	5	7	6	1	2	1			1			205
Combretum celastroides subsp. celastroides		4	2	2	3													1															4							16
Combretum collinum subsp. collinum		11	1		37	31	8	3	4	5						1		1	3	2																				107
Combretum hereroense var. hereroense	1				3	6				8	1	7	7	4	3	6	21	6	5	3	1	2				1	1		5		4	1		3	1	4	1				105
Combretum imberbe					1	1				5	1	8	4	2		1	1			2	2	4				4	1	3	2		3					19			1		65
Combretum microphyllum																												1								3					4
Combretum mossambicense	1	6	1	1	11		2		2	6		3	4	1	6	5	3		14	2	3	19	2	1		5	1	7	5	6	3	2	2			21		1	1	1	148
Combretum padoides																						6						2	1	4	3	1						1		18
Combretum zeyheri	1	2			18	19	4	1	4	6					4	2	4	2	5			2		2	2	1			1				1				1			82
Commiphora africana	1				3							2		3	3		7		1			1						2												23
Commiphora caerulea																		8																2						9
Commiphora edulis subsp. edulis	1																	4				6						3	1	2						2		1			20
Commiphora glandulosa	1	2	1	1	1	1									1		2	2	2		1	1						1		1			1			1					20
Commiphora marlothii																														1										1
Commiphora mollis		1													1			4				1						3		2							1				13

Species names	0	1.1	1.1.1	1.1.2	1.2	1.3	2.1	2.2	2.3	3.1	3.1.1	4.1	4.2	4.3	4.4	4.5	4.6	4.6.1	4.7	4.8	4.9	5.1	5.1.1	5.2	5.3	6.1	6.1.1	7.1	7.2	8.1	8.2	8.2.1	8.3	8.4	8.4.1	9.1	10.1	10.2	11.1	11.2	Total
Commiphora mossambicensis												1																												1
Commiphora neglecta																																	1							1
Commiphora pyracanthoides	1				1							2				2	4	3	1	1																				15
Commiphora schlechteri																																	1							1
Commiphora zanzibarica																						1							1						4					6
Coptosperma littorale							1		5									1				2		1					1											11
Coptosperma neurophyllum								1																																1
Coptosperma zygoon		5		1	2	3	3	1							1	2			1													2				1		22
Cordia goetzei			1			1				2						1		1																	4					10
Cordia grandicalyx																						6				1		1		2									10
Cordia monoica																		4						1							1								6
Cordyla africana													1									1								1				16					19
Crossopteryx febrifuga					1	1	1			1					1		1	1				2			1	2	1	1	1	1	4								20
Croton gratissimus														1			1	1				1						2				1							7
Croton longipedicellatus var. longipedicellatus																						1																	1
Croton madandensis														1								1											1						3
Croton megalobotrys																																		16					16
Croton menyharthii																		1															1						2
Croton pseudopulchellus		1			1													2				1		1						6	2	5	1					20
Croton steenkampianus			1																																				1
Dalbergia arbutifolia subsp. arbutifolia																						4		1		1								2					8
Dalbergia melanoxylon		2			8	13	1		1	6		6	2	5	4	4	19	3	12	2	1	6			2	2	1	2	2		1				3				108
Dalbergia nitidula		1			18	4	4	2	5						1			1				1		1															38
Deinbollia xanthocarpa																																		14					14
Dichrostachys cinerea subsp. africana	2	2	1	1	11	18	1	2	2	6	1	7	2	5	7	6	19	7	11	5	2	15		2	2	4	1	5	4	4	4	1	2	1	1	11	1		1		177
Diospyros loureiriana subsp. loureiriana	1	5			5	9	5	2	2	5			1		1	2	1		5		1	14	1	2	2	2		1		2					13			1		83
Diospyros lycioides															2							3							1		5	2							13
Diospyros mespiliformis		1			2	2				5	1			2			3		2	3	2	7				2	1		1		5				14				53
Diospyros squarrosa												3										1						2							1				7
Diplorhynchus condylocarpon					22	30	6	4	4	3					1		5	2	2					1	2				1										83
Dombeya kirkii										1										1				1										2					5
Dovyalis hispidula																						4							3					3					10
Drypetes mossambicensis	1	5			6					5		1	5			5	2		8	1	2	14				4		4		2			1		13		1	1		81
Drypetes reticulata																																		1					1
Ehretia amoena		2		1	5	2			1	5		2	2	2	1	2	7	2	5	3	1	2		1		3		3	2	1	1			1		10	1				68
Elaeodendron transvaalense										1							3			1																				5
Elephantorrhiza elephantina					2																																			2
Elephantorrhiza goetzei subsp. goetzei	1				1	2						2	1									7						4		2									20
Entandrophragma caudatum	1	2					1											1				6		1				2		4			1						19
Erythrina livingstoneana																						1																	1
Erythrococca menyharthii		3		2	13	1	2		1	5						1	1		7	1																				37
Erythrophleum africanum					7	11	2	3	4															1																28
Erythroxylum emarginatum		1	2		1	1			2	2									2	1																				12
Euclea divinorum		2			6				1	6	1		4	2	3	5	6		8	4	1	1							3		3			1		4	1			62
Euclea natalensis subsp. angustifolia					8	19	2	2	3	4								2	1	2	1																			44
Euclea racemosa subsp. schimperi					1	1				3				4		5	15	7	3	3															2	1		1			1	47
Euphorbia cooperi var. cooperi																		3				3		1				2												9
Euphorbia espinosa	1																	1				3		1				1		2	1	1								11
Euphorbia griseola subsp. griseola																														1										1
Euphorbia ingens					3					2																								1						6

Species names	0	1.1	1.1.1	1.1.2	1.2	1.3	2.1	2.2	2.3	3.1	3.1.1	4.1	4.2	4.3	4.4	4.5	4.6	4.6.1	4.7	4.8	4.9	5.1	5.1.1	5.2	5.3	6.1	6.1.1	7.1	7.2	8.1	8.2	8.2.1	8.3	8.4	8.4.1	9.1	10.1	10.2	11.1	11.2	Total
Euphorbia tirucalli																						4		1					1							2					8
Excoecaria bussei																																			1					1
Faidherbia albida																																			5					5
Ficus abutilifolia																						7		1				2	1	2	2					1				16
Ficus bussei																																			1					1
Ficus capreifolia																																			1					1
Ficus ingens																						1																		1
Ficus sansibarica subsp. sansibarica																													1											1
Ficus stuhlmannii																																			1					1
Ficus sycomorus subsp. sycomorus																						1													5					6
Ficus tettensis																															1									1
Flacourtia indica																								1																	1
Flueggea virosa subsp. virosa	1				3	6			1	8	1	6	5	5	4	10	9	4	10	6	3	8	2			5	1	3	4		5	1		2	1	19			1	1	135
Friesodielsia obovata																						1	1	2																	4
Galpinia transvaalica																																				1					1
Garcinia livingstonei																		1																	4					5
Gardenia resiniflua subsp. resiniflua										1		1	2	1	1			6				11		2		2		4		5	1				2		1			40
Gardenia sp. c.f. cornuta																	1																		1					1
Gardenia volkensii subsp. volkensii var. volkensii		1	1		6	2	2		4	2									1	1		1										1								22
Gomphocarpus fruticosus subsp. fruticosus								1																																1
Gossypium herbaceum subsp. africanum										1								1	2																1					5
Grewia bicolor	1		1		10	1	2			6		3	1	1	2	7	19	11	6	4	2	4				2		3	3	1			3	1	4		1			99
Grewia caffra	1		1		1							1	1	3	3			2		1		9	1			2		5	4	3	3	1					1			43
Grewia flavescens		2		3	5				1	4		1			1	4	1	7	5	1	1	6						2		1	1				2				1	49
Grewia hornbyi		1										1				1	1		2																					6
Grewia inaequilatera																																			3					3
Grewia lepidopetala					2					2						2	6	2	7	3															2					26
Grewia micrantha		2			5	4			1										2																					14
Grewia monticola					1					2					2	1	1	1	1					1				4		1					1	1				17
Grewia subspathulata		1				2												1									1	1				1			1				1	9
Grewia sulcata var. sulcata																1				1																				2
Grewia villosa var. villosa																		4																						4
Guibourtia conjugata		13	3	3	33	17	5	1	4	2			1		2			2	9	2								3			1	5							106
Gymnosporia buxifolia												1				1		1								1														4
Gymnosporia maranguensis		1			2	1								1							1														3					9
Gymnosporia pubescens						1				1		2		2		1	14	1	3	1								1								1					28
Gymnosporia putterlickioides		1			3									2	1	2			2	2	1	2							1	1	2	1	1			2		1	1	1	27
Gymnosporia senegalensis					9	8				3		1				1			2	1		2														1					28
Gyrocarpus americanus subsp. africanus	1																					3						1		2							1			8
Heinsia crinita subsp. parviflora		2	1	1	8		1		4	1					1				1			3	1						1				2							27
Hexalobus monopetalus var. monopetalus		1					1							1	2		1			2		1		2					3		2					1	1			18
Hippocratea africana var. richardiana		3																	1	1															2				1	8
Hippocratea buchananii					1					1		3	2			4	6	1	2	2	1	3						5	1	1					4		1		1	39
Hippocratea crenata	1	1		1	3					3	1		3			5		1	6	2	1	5	1	1		2		1		2					5		1	1		47
Hippocratea indica		1		1	3					2			1				1		5	3		2	1					1	2						3	1				27
Hippocratea longipetiolata		1		1	4	1				1						1	1		1				1												3					15
Hippocratea parviflora																					1																			1
Holarrhena pubescens					1	5	2	1	1	1												1	1	1	2	1														17
Hugonia orientalis		9	3	3	27	10	9	3	7	5					3				5	1		15	1	3						2			2				1			109
Hymenocardia ulmoides		5	1	2	11	1			5						1							5	1	2						1			1							36

Species names	0	1.1	1.1.1	1.1.2	1.2	1.3	2.1	2.2	2.3	3.1	3.1.1	4.1	4.2	4.3	4.4	4.5	4.6	4.6.1	4.7	4.8	4.9	5.1	5.1.1	5.2	5.3	6.1	6.1.1	7.1	7.2	8.1	8.2	8.2.1	8.3	8.4	8.4.1	9.1	10.1	10.2	11.1	11.2	Total
Hymenodictyon parvifolium subsp. parvifolium																						2		1																3
Hyphaene petersiana								1		1		1																							6					9
Jasminum fluminense							1									1						1																		3
Jasminum stenolobum		1					2			2		3	1		2		11	1	4	1		2						2		2					1					35
Jatropha spicata																											1		1										2
Julbernardia globiflora							6	4																	1														11
Kigelia africana																						2				1			1					16					20
Kirkia acuminata	1							2	5	1		2	1		1			6	1		1	12		2	1			8	1	6	3	2		2	1	4	1	1			57
Lagynias dryadum																																	1							9
Landolphia kirkii																								1																1
Lannea schweinfurthii var. stuhlmannii	2	3	1		24	5	3	3	3	4			1	1	5	2	3	1	8	1	1	15		2		2	1	4	2	6	4	2		1		3	1	1			115
Lantana camara																																			3					3
Lantana rugosa						1				1							5	3	2								1	1	1											15
Lecaniodiscus fraxinifolius													2			1					2	7		1		1									11					25
Leptactina benguelensis subsp. pubescens																		1																						1
Leptactina delagoensis subsp. delagoensis		1	1	1	1				3																														7
Maclura africana																						1													12					13
Maerua angolensis		1			4										1		2	2					1	1								1			2					15
Maerua decumbens	1												3						1		1	4							2						3					15
Maerua kirkii													1			1						10	1	2					4						3					22
Maerua parvifolia	1	6	1	1	10	2	1			5		1	5	3	2	10	18	10	19	2	2	4				2		2	2		1			2	1	4	1	1	1	1	121
Manilkara concolor						1				1								2									1													5
Manilkara mochisia	1				2					2			3	2	1		5	4	1	1		4				2		1		2				2			1	1			35
Margaritaria discoidea subsp. nitida			1				6	3	6													3		2						1	3									25
Markhamia zanzibarica	1	4		3	6	4	4	1	2	3		4	8	2	3	7	1	2	16	1	4	20	2	2		4	1	6	3	5	1	2				7	1	1	1	1	133
Milicia excelsa																																			1					1
Millettia stuhlmannii			1				1																																	2
Millettia usaramensis subsp. australis				3	1													1	1			9	2	2	1	1						1								22
Mimusops zeyheri										1																									3					4
Monodora junodii var. junodii		8	3	3	12		6	4	7	4	1	1				1		2	1			19	1	3		2		2	1	4			1			6	1	1			94
Mundulea sericea					2					1			2		2	1	8	1	1	2		3							1						1					25
Mystroxylon aethiopicum						1										1		1																	2	1				6
Neoholstia tenuifolia var. tenuifolia										2	1						1																1		1					6
Newtonia hildebrandtii var. pubescens		1								1																				1		1			1					5
Ochna barbosae					1		2															1		1	1															6
Ochna inermis	1				1						1		3					1				3						3	2	2	2							1	20
Ochna natalitia					2	3	2	1	2	2																														12
Ochna pulchra subsp. pulchra		1			13	29	8	1	2										1																	1				56
Olax dissitiflora																		2																						2
Olea europaea subsp. cuspidata																	1																							1
Oncoba spinosa																						1																		1
Ormocarpum trichocarpum						1				3		1		2	1	3	14	3		1						1														30
Ozoroa paniculosa var. paniculosa	1	2			17	17	2	1	1	4					2	2	6	3	3	1									1				1						64
Ozoroa reticulata subsp. reticulata var. crispa					1																																		1
Pachypodium saundersii																						2							1										3
Pappea capensis					1					1			1	1		2	8	7															2			1			1	25
Pavetta gracillima		2			1					6			2		2	2	3	1	2	3		2		1					2	1			1		9	1		1		42
Peltophorum africanum	1				2	6	1			6	1	1			3	1	4	1	1									3		3									34
Periploca nigrescens																																			1					1
Philenoptera bussei		6		3	10		4		1	1							1		1	1	1	10	2	2	1				2	1		3			1					51

Species names	0	1.1	1.1.1	1.1.2	1.2	1.3	2.1	2.2	2.3	3.1	3.1.1	4.1	4.2	4.3	4.4	4.5	4.6	4.6.1	4.7	4.8	4.9	5.1	5.1.1	5.2	5.3	6.1	6.1.1	7.1	7.2	8.1	8.2	8.2.1	8.3	8.4	8.4.1	9.1	10.1	10.2	11.1	11.2	Total
Philenoptera violacea	1					6	1	1		8	1	6	3		2	2	2	1	5	3	2	8	1		2	5	1	4	2		2					21	1	1			92
Phyllanthus pinnatus	1	5		3	5	1				5		1	6	2	1	4	3	4	7	2	1	20	2	2		3	1	5	3	6	6	2	2			5	1	1		1	111
Phyllanthus reticulatus var. reticulatus																					1	1						1		1					6					10
Piliostigma thonningii																																			1					1
Pluchea dioscoridis																																			1					1
Pouzolzia mixta																						1							1											2
Pseudolachnostylis maprouneifolia					18	28	5	3	2	2					5		2	1	5	1				1	2			2		3						1				81
Psilotrichum scleranthum																														1										1
Psydrax livida					1		2	2	4													2		1				2												14
Ptaeroxylon obliquum		1			1										1									1					2				1			3	1				11
Pteleopsis anisoptera					1																																			1
Pteleopsis myrtifolia		8	3		36	30	7	3	7	3					2			2	8	2		1		1	1				2				2							118
Pterocarpus angolensis						5																																		5
Pterocarpus brenanii												4	1								1							1												7
Pterocarpus lucens subsp. antunesii		8		3	15	1			2									1	1			7		1									2							41
Pterocarpus rotundifolius subsp. rotundifolius																		1																						1
Putterlickia verrucosa					1	2																																		3
Rauvolfia caffra																																			1					1
Rhigozum zambesiacum													2	1	1	4	5		1	1		1							3		1			1		3				24
Rhoicissus revoilii					6	2				5		3	1	2			3	3				5					5	1			1									37
Rhoicissus tridentata						1		1		1												1					1									1				6
Rhus gueinzii var. spinescens																																			1					1
Rhus leptodictya																																				1				1
Rinorea elliptica																																			1					1
Rotheca wildii																															1				1					2
Ruspolia seticalyx																													1											1
Salvadora australis																		1																						1
Salvadora persica var. pubescens																2																			4					6
Schotia capitata										1							1																							2
Schrebera trichoclada					1	1	2															2		1																7
Sclerocarya birrea subsp. caffra	1	3			23	25	5	1	1	3		2	1		2	3	4	1	11	1		5		1	1	2		3		1	1				1	2	1			105
Securidaca longepedunculata						2	3																																	5
Senna occidentalis																																			2					2
Senna petersiana		5	1	1	29	21	7	4	7	5		1			2	1	4	3	12	4	1	1	1	1	1		1				1		3		1	5				1	124
Senna septemtrionalis																																			3					3
Sideroxylon inerme subsp. diospyroides																	4	3															1							8
Spirostachys africana		3			11	10	1	1		8	1	1	4	5		6	7		12	6	2	4				4		1	2		2				1	11	1	1	1	1	107
Stadmannia oppositifolia subsp. rhodesica																						2									1						1	1			5
Steganotaenia araliacea var. araliacea																		1				3		1								1		1			1				8
Sterculia rogersii		2			1							1	1				4	6	1		1	6					3		2	2			1							31
Strophanthus kombe	1	2		3			1												1			4		1					4	1	1	2			2				23
Strychnos decussata	1	4		2	3					2			2		2		1	1	1	1		10		1		1		2	2	3	3		2			1				45
Strychnos henningsii																						1		1																2
Strychnos lucens	1																																							1
Strychnos madagascariensis	1	5	3	2	32	28	7	2	6	7		1	3	2	5	3	7	4	12	3		13	1	2	2	2		5	4	3	1		2				1		1		170
Strychnos potatorum		7		1	14	6	2		1	8		3	1			6	1	1	11	5	1	6	1			2		1	1		1					10	1		1		92
Strychnos spinosa		4	1	2	18	18	5		3									1		1		1	2		2	1						1				2			1		63
Suregada zanzibariensis									4	1																														5
Synaptolepis alternifolia					1	3	4	2	6													1		2																19
Tabernaemontana elegans								1		1												2	1	2												13					20

Species names	0	1.1	1.1.1	1.1.2	1.2	1.3	2.1	2.2	2.3	3.1	3.1.1	4.1	4.2	4.3	4.4	4.5	4.6	4.6.1	4.7	4.8	4.9	5.1	5.1.1	5.2	5.3	6.1	6.1.1	7.1	7.2	8.1	8.2	8.2.1	8.3	8.4	8.4.1	9.1	10.1	10.2	11.1	11.2	Total
Terminalia prunioides					1					1				2		2	20	10	2		1												3		3		1		1	47
Terminalia sericea		5			33	30	5	1	2	4					3	1	5	1	12					1	2	1			2		1		1								110
Terminalia stenostachya																									2	1															3
Thilachium africanum	1	4		2	1	1		1		4			5		1	5		5	3	1	2	12	1	2		2				3	1		4			18	1	1	1		82
Tiliacora funifera																						3	2	2												4					11
Tinnea rhodesiana																						2																			2
Tinnea zambesiaca																															1										1
Tricalysia allenii		7		3	16	5	2	1	2	5		2			3	1		3	11	2	1	3	2	1	1			4	4	1	3		1			10	1	1			96
Tricalysia jasminiflora var. jasminiflora																																			2					2
Tricalysia junodii		3		1	5	2				2					2	1			8	2		1					1		1											29
Trichilia emetica subsp. emetica																																			11					11
Turraea obtusifolia					1	1			1								1		4	1																				9
Tylosema fassoglense					1	1											1																							3
Uvaria gracilipes		2			7	10		2	2	2						2	2	3	1			1												2		1					37
Vangueria infausta subsp. infausta		3			16	15	8	3	1	2								2		1				1	1					1						1					55
Vangueria randii subsp. randii																						1										1								2
Vepris bremekampii		1					1		4	1												5		2								1	1							16
Vepris myrei																	1	1				2											1		1					6
Vepris reflexa										1																															1
Vepris trichocarpa									1																																1
Vepris zambesiaca									2								1	1	1								1						1								7
Vitex ferruginea subsp. amboniensis	1	1			1							3	4			1		1			1	12				3		7		5						6			1		47
Vitex mombassae		5	2		1		1	1	5			1	2			1			1			10		3		3			3	5	2	2			2					50
Vitex patula									1				1					1			1	5				1		2								1					13
Vitex payos var. payos																						1	1																		2
Withania somnifera																																			1					1
Wrightia natalensis			1	1																											2	1							5
Xanthocercis zambesiaca													1													1				1					19					22
Xeroderris stuhlmannii		10	2	1	37	24	8	3	4	3			2		5	1	1	1	16	1		14	1	3	2	2		5	3	7	4	2	2			3	1				168
Ximenia americana var. microphylla	2				3		1			3		2	2		1	3	7	3	4								3	2		1										37
Ximenia caffra						5	3						1									2																			11
Xylia torreana				3																		4	1	1																9
Zanthoxylum humile						1										2	11	2	3	2								1					1							23
Ziziphus mucronata										1		1	1		3	1			1	1		5	1			3	1	3	1		1					6	1				31
Ziziphus pubescens																																			1	1				2

10.6 Summary Tables for Vegetation Types.

Table 10.6.1. Summary Tables for Vegetation Types: Landscape.

LANDSCAPE TYPE	VEGETATION TYPES																																								
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Alluvial terrace																				1	3															22					**26**
Bottom of depression										6	1						1																								**8**
Flat, level, plain, sand plain - bottom		1										1	1	1		7			6	2	1																				**20**
Gentle slope, gently undulating		7		2	8	6	1		3	1		5	3	4	4	4	18		5	3		9	1			4	1	1	3		1		4			1				1	**100**
Flat, level, plain, sand plain - upland	1	5	3	1	26	20	7	3	3	1		2	2		1	2			9			1	1			1					2		1			1					**93**
Ridge top					4	5	1	1					2		1		2	1	2			2		1	2			1	1	1									1		**28**
Hill, kopje, ridge, low ridge	1								1			1			1		4	5				7		2				7	1	5	3	2		1	1		1	1			**44**
Cliff, escarpment, steep slope																		5				3								1				2							**11**
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Alluvial terrace																				17	75															92					**8**
Bottom of depression										75	100						4																								**2**
Flat, level, plain, sand plain - bottom		8										11	13	20		54			27	33	25																				**6**
Gentle slope, gently undulating		54		67	21	19	11		43	13		56	38	80	57	31	72		23	50		41	50			80	100	11	60		17		80			4				100	**30**
Flat, level, plain, sand plain - upland	50	38	100	33	68	65	78	75	43	13		22	25		14	15			41			5	50			20					33		20			4					**28**
Ridge top					11	16	11	25					25		14		8	9	9			9		33	100			11	20	14									100		**8**
Hill, kopje, ridge, low ridge	50								14			11			14		16	45				32		67				78	20	71	50	100		33	100		100	100			**13**
Cliff, escarpment, steep slope																		45				14								14				67							**3**
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.2. Summary Tables for Vegetation Types: Geology.

GEOLOGY TYPE	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded																	1					1			1						1	1									5
No surface rock	1	13	3	3	38	30	9	4	7	8	1					13	10	1	21	6	2				1		1					3			2			1		178
Alluvium																	1				1													19					21
Sandstone						1											3	8	1													1	2							16
Pebbles																	9	1																1						11
Calcrete																	1																						1	2
Basalt												5		2													4								1					12
Dolerite												2			1											1														4
Rhyolite	1												1	2	2											1			2	1	4					1	1	1			17
Gabrrodiorite														1																										1
Trachyte												1	1									2																		4
Syenite												1	4		4							6	1				1	1	1		1									20
Granite													1									7	1	1		1		1	1	1	1									15
Granodiorite																		1				3				2		2	1	3	1									13
Granophyre													1								1	3		2				1		1					1					10
Mylenite - quartz-garnet																																	1							1
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded																	4					5			50						50	20								2
No surface rock	50	100	100	100	100	97	100	100	100	100	100					100	40	9	95	100	50				50		100					60			8			100		54
Alluvium																	4				25														79					6
Sandstone						3											12	73	5													20	67							5
Pebbles																	36	9																100						3
Calcrete																	4																						100	1
Basalt												56		40													44								4					4
Dolerite												22			14										20															1
Rhyolite	50												13	40	29										20			40	14	67					4	100	100			5
Gabrrodiorite														20																										0
Trachyte												11	13									9																		1
Syenite												11	50		57							27	50				11	20	14		50									6
Granite													13									32	50	33		20		11	20	14	17									5
Granodiorite																		9				14				40		22	20	43	17									4
Granophyre													13								25	14		67			11		14						4					3
Mylenite - quartz-garnet																																	33							0
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.3. Summary Tables for Vegetation Types: Soil.

SOIL TYPE	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded		1			2											1	1					1														6					6
Clay											1	8	2	1		1	3				1					1		2								10					30
Loamy clay						1						1	3	2		2		1		1	2	2			1	3	1	2								3		1		1	27
Clay loam	1												2		1	5	7	5	1	1	1	9						3	1	1			1			7					46
Sandy clay loam	1									3				2	2	2	5		3	1		2				1			1	1				2		2	1				29
Loam						1				1					1	1	6	2				2								1	2	1	1		1	1					21
Sandy loam		1			2	4		1		3			1		3	1	3	1	7	1		3	1					1	1	2	2		1								39
Loamy sand		6	1	2	21	21	3	3	6									1	9	2		1		1	1			1	2	1	2	1									85
Sand		5	2	1	13	4	6		1	1								1	2				1	1									2	1		1			1		43
Rock																						2		1						1											4
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**7**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded		8			5											8	4					5														2					2
Clay											100	89	25	20		8	12				25					20		22								42					9
Loamy clay						3						11	38	40		15		9		17	50	9			50	60	100	22								13		100		100	8
Clay loam	50												25		14	38	28	45	5	17	25	41						33	20	14			20			29					14
Sandy clay loam	50									38				40	29	15	20		14	17		9				20			20	14				67		8	100				9
Loam						3				13					14	8	24	18				9								14	33	50	20		100	4					6
Sandy loam		8			5	13		25		38			13		43	8	12	9	32	17		14	50					11	20	29	33		20								12
Loamy sand		46	33	67	55	68	33	75	86									9	41	38		5		33	50			11	40	14	33	50									26
Sand		38	67	33	34	13	67		14	13								9	9				50	33									40	33		4			100		13
Rock																						9		33						14											1
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.4. Summary Tables for Vegetation Types: Slope.

SLOPE	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Level (0-2)	1	10	3	3	36	29	9	4	6	8	1	6	8	5	4	11	13		20	6	4	8	2	1	2	4		1	1	1	2		2			22			1	1	235
Gentle (2-10)	1	3			2	2						2			3	2	12	2	2			6				1	1	2	4	1	3		3			1					53
Moderate (10-45)									1			1						8				8		2				5		4		2		3	1	1	1	1			38
Steep (>45)																		1										1		1	1										4
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Level (0-2)	50	77	100	100	95	94	100	100	86	100	100	67	100	100	57	85	52		91	100	100	36	100	33	100	80		11	20	14	33		40			92			100	100	71
Gentle (2-10)	50	23			5	6						22			43	15	48	18	9			27				20	100	22	80	14	50		60			4					16
Moderate (10-45)									14			11						73				36		67				56		57		100		100	100	4	100	100			12
Steep (>45)																		9										11		14	17										1
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.5. Summary Tables for Vegetation Types: Aspect.

ASPECT	VEGETATION TYPES																																						
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded						1																2																		3
Level	1	6	3	1	33	23	8	3	4	7	1	3	4	1	1	6	5		13	3	3	6	2	1	2	2			1	2	1	1	1			20			1		169
Undulating	1	2		1		1			1			1		1	2	2	6					2				1		2	2		1	1	1	1	1						30
Ridge									1						1				1					2						1											6
North		2			1	1						2		1		1	4	6	2	1	1	3					1		1				1					1		1	30
North East					2													2		1		1				1					1									8
East										1			1		1	1		1	1			2								1	1			1		1				12
South East																	1					1						1												3
South		1			1	3	1	1					2	1	2	2	3	2	1			3				1		1	1	1						3	1				31
South West						1			1				1				1		3			2						3		1			1								14
West				1		1						2		1		1	3		1									1		1	2		1	1						16
North West		2			1							1					2			1								1												8
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded						3																9																		1
Level	50	46	100	33	87	74	89	75	57	88	100	33	50	20	14	46	20		59	50	75	27	100	33	100	40			20	29	17	50	20			83			100		51
Undulating	50	15		33		3			14			11		20	29	15	24					9				20		22	40		17	50	20	33	100						9
Ridge									14						14				5					67						14										2
North		15			3	3						22		20		8	16	55	9	17	25	14					100		20				20					100		100	9
North East					5													18		17		5				20					17									2
East										13			13		14	8		9	5			9								14	17			33		4					4
South East																	4					5						11													1
South		8			3	10	11	25					25	20	29	15	12	18	5			14				20			11	20	14						13	100				9
South West						3			14				13				4		14			9							33		14			20							4
West				33		3						22		20		8	12		5										11		14	33		20	33						5
North West		15			3							11					8			17									11													2
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.6. Summary Tables for Vegetation Types: Density of Termitaria.

DENSITY OF TERMITARIA (No per ha)	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded		1			1	3			1						1				1														1			1				10
None per ha		5	1		9	19	4	1	2	2		2				5	10	10	13	2	3	3						7	1	2				1		6		1			109
1-5 per ha	2	7	1	3	27	9	5	3	4	6	1	7	8	5	5	8	15	1	8	4	1	15	2	3	2	5	1	2	4	5	4	2	5	1	1	17			1	1	201
>5 per ha			1		1										1							4									2					1					10
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded		8			3	10			14						14				5														33			100				3
None per ha		38	33		24	61	44	25	29	25		22				38	40	91	59	33	75	14						78	20	29				33		25		100			33
1-5 per ha	100	54	33	100	71	29	56	75	57	75	100	78	100	100	71	62	60	9	36	67	25	68	100	100	100	100	100	22	80	71	67	100	100	33	100	71			100	100	61
>5 per ha			33		3										14							18									33					4					3
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.7. Summary Tables for Vegetation Types: Size of Termitaria.

SIZE OF TERMITARIA (DIAMETER m)	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded		1			1	3			1						1				1														1			1				10
None		5	1		9	19	4	1	2	2		2				5	10	10	13	2	3	3						7	1	2				1		6		1			109
Small (<1m)		1		1	1	1						1					4														1		1	1					12
Medium (1-2m)		3	1		2	4	2		1		1	3	4	1	4	2	6		4	1	1	5	1			1			2		2		1		7					59
Large (>2m)	2	3	1	2	25	4	3	3	3	6		3	4	4	2	6	5	1	4	3		14	1	3	2	4	1	2	2	5	4	2	3	1		10			1	1	140
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded		8			3	10			14						14				5														33			100				3
None		38	33		24	61	44	25	29	25		22				38	40	91	59	33	75	14						78	20	29				33		25		100			33
Small (<1m)		8		33	3	3						11					16														20		100	4					4
Medium (1-2m)		23	33		5	13	22		14		100	33	50	20	57	15	24		18	17	25	23	50			20			40		33		20			29					18
Large (>2m)	100	23	33	67	66	13	33	75	43	75		33	50	80	29	46	20	9	18	50		64	50	100	100	80	100	22	40	71	67	100	60	33		42			100	100	42
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.8. Summary Tables for Vegetation Types: Height of Upper Tree Layer.

HEIGHT TREE LAYER 1 (m)	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded		1			1	1	2		1			1				1	1		1											1		1	1								13
Absent			1		11	17						1				1	9					1	2						3	1											47
<10					2	2											10	2	1	1								1													19
10-15		1			1	3	3	3	2	4	1	2		2	1	1	5	4	4	1		5				2				2	2		2	1						1	53
15-20	2	11	2	2	19	7	4	1	4	4		5	7	3	5	8		5	12	3	3	15		3	2	3	1	5	1	1	4	1	2	2	1	11	1	1	1		162
>20				1	4	1						1		1	2				4	1	1	1						3	1	2							13					36
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded		8			3	3	22		14			11				8	4		5											14		50	20								4
Absent			33		29	55						11				8	36					5	100					60	14											14
<10					5	6											40	18	5	17								11													6
10-15		8			3	10	33	75	29	50	100	22		40	14	8	20	36	18	17		23				40				29	33		40	33						100	16
15-20	100	85	67	67	50	23	44	25	57	50		56	88	60	71	62		45	55	50	75	68		100	100	60	100	56	20	14	67	50	40	67	100	46	100	100	100		49
>20				33	11	3							13		14	15			18	17	25	5						33	20	29							54					11
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.9. Summary Tables for Vegetation Types: Height of Second/Lower Tree Layer.

HEIGHT TREE LAYER 2 (m)	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded		3	1		6	4	4	1	1	1		1	1			5	3	1	2		3	6		1		1	1			1		1	1	1		6			1		57
Absent					1	1											4		1									1													8
3-6	1				4	4			3	2		4	4		4	2	12	2	1	1		6	1			1		1	4	1	2			1		4					65
7-8	1			1	11	14		3	2	2		2	1	4	3	3	4	2	10	1		8				2		6	1	3	3	1		1	1	8	1				99
9-12		8	2	2	15	7	4		1	3	1	2	2	1		2	2	6	1	4	1	1	1		2	1		1		2	1		3			4		1		1	82
>12		2			1	1	1									1			7			1		2								1				2					19
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**7**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded		23	33		16	13	44	25	14	13		11	13			38	12	9	9		75	27		33		20	100			14		50	20	33		25			100		17
Absent					3	3											16		5									11													2
3-6	50				11	13			43	25		44	50		57	15	48	18	5	17		27	50			20		11	80	14	33			33		17					20
7-8	50			33	29	45		75	29	25		22	13	80	43	23	16	18	45	17		36				40		67	20	43	50	50		33	100	33	100				30
9-12		62	67	67	39	23	44		14	38	100	22	25	20		15	8	55	5	67	25	5	50		100	20		11		29	17		60			17		100		100	25
>12		15			3	3	11									8			32			5		67								20				8					6
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.10. Summary Tables for Vegetation Types: Total Woody Cover.

TOTAL WOODY COVER (%)	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
1-10					1	1	3		1								1	2	1			10				3				1	1					4			1		30
11-25		3			20	16	4		3	6	1	4	3		2	2	7	6	3	3	2	8	1			2		1	4	4	3		1		1	11	1	1			123
26-50	2	7	1	1	17	11	2	2	3	1		3	4	5	5	9	8	3	15	3	2	3		2	2		1	4	1	2	1	1	1	1		4				1	128
51-75		2	2	1		3		2		1		2	1			2	9		3			1	1	1				4			1	1	2	1		2					42
76-100		1		1																												1	1		3					7
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**7**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
1-10					3	3	33		14								4	18	5			45				60				14	17					17			100		9
11-25		23			53	52	44		43	75	100	44	38		29	15	28	55	14	50	50	36	50			40		11	80	57	50		20		100	46	100	100			37
26-50	100	54	33	33	45	35	22	50	43	13		33	50	100	71	69	32	27	68	50	50	14		67	100		100	44	20	29	17	50	20	33		17				100	39
51-75		15	67	33		10		50		13		22	13			15	36		14			5	50	33				44			17	50	40	33		8					13
76-100		8		33																												20	33		13					2
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.11. Summary Tables for Vegetation Types: Total Tree Cover.

TOTAL TREE COVER (%)	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
1-10			1		6	9	6		4	1		1	3		1	3	18	4	3	2	1	13	1			4			1	3	2				1	8	1		1		98
11-25	1	4	1		20	16	1	1		5	1	5	3	3	2	6	5	5	11	3	3	7	1	1		1	1	3	4	2	2		1			9		1		1	130
26-50	1	8	1	3	12	6	2	1	3	2		2	2	2	4	4	2	2	7	1		2		1	2			4		2	1	1	2	1		4					85
51-75		1						2				1							1					1				2			1	1	1	1		1					13
76-100																																1	1		2					4
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
1-10			33		16	29	67		57	13		11	38		14	23	72	36	14	33	25	59	50			80			20	43	33				100	33	100		100		30
11-25	50	31	33		53	52	11	25		63	100	56	38	60	29	46	20	45	50	50	75	32	50	33		20	100	33	80	29	33		20			38		100		100	39
26-50	50	62	33	100	32	19	22	25	43	25		22	25	40	57	31	8	18	32	17		9		33	100			44		29	17	50	40	33		17					26
51-75		8						50				11							5					33				22			17	50	20	33		4					4
76-100																																20	33		8					1
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.12. Summary Tables for Vegetation Types: Total Shrub Cover.

TOTAL SHRUB COVER (%)	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
1-10	2	11	1		36	20	9	3	6	8	1	6	5	4	7	4	5	8	11	4	1	18	1	3	2	5		7	2	5	6	2	4	3		16	1	1	1		229
11-25			1	2	2	9			1			3	2			6	10	3	9	2	1	4					1	1	3	2			1		1	7				1	72
26-50		1				2		1						1		2	3		2		2		1					1								1					17
51-75		1	1	1									1			1	7																								12
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
1-10	100	85	33		95	65	100	75	86	100	100	67	63	80	100	31	20	73	50	67	25	82	50	100	100	100		78	40	71	100	100	80	100		67	100	100	100		69
11-25			33	67	5	29			14			33	25			46	40	27	41	33	25	18					100	11	60	29			20		100	29				100	22
26-50		8				6		25						20		15	12		9		50		50					11								4					5
51-75		8	33	33									13			8	28																								4
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.13. Summary Tables for Vegetation Types: Total Herbaceous Cover.

TOTAL HERBACEOUS COVER (%)	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded						1						1					1					3					1					1									8
1-10		5		1	1				2				1	2		5	6	2	7	2		2		1					1	2	3	1	3	1	1	3					52
11-25	1	5	2	1	9	3	2	2	1	2		1	1	1	2	4	6	3	7	4	2	5	1					5	1		2	1				8			1		83
26-50		3		1	18	19	6	2	2	2		5	5	2	4	2	10	4	6		2	6		2	1	1		3	3	5	1		1	2		7		1		1	127
51-75	1		1		9	7	1		1	4			1		1	2	2	2	1			4	1		1	2		1								1	1				44
76-100					1	1			1		1	2							1			2				2										5					16
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded						3						11					4					14					100					20									2
1-10		38		33	3				29				13	40		38	24	18	32	33		9		33					20	29	50	50	60	33	100	13					16
11-25	50	38	67	33	24	10	22	50	14	25		11	13	20	29	31	24	27	32	67	50	23	50					56	20		33	50				33			100		25
26-50		23		33	47	61	67	50	29	25		56	63	40	57	15	40	36	27		50	27		67	50	20		33	60	71	17		20	67		29		100		100	38
51-75	50		33		24	23	11		14	50			13		14	15	8	18	5			18	50		50	40		11							4	100				13
76-100					3	3			14		100	22							5			9				40										21					5
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.14. Summary Tables for Vegetation Types: Litter Cover.

LITTER COVER (%)	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded					1												1																									2
<10	2	7	1		27	19	7	1	3	6	1	4	8	2	4	10	12	8	11	3	4	15		2	1	4	1	5	5	7	6	1	1	1	1	16		1	1		208
10-20		5	2	2	10	12	1	2	4	2		5		3	3	2	9	2	9	3		7	2	1	1	1		4					3	1		5	1			1	103
20-50		1		1				1									2	1	2																	2					10
>50							1									1	1															1	1	1		1					7
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded					3												4																									1
<10	100	54	33		71	61	78	25	43	75	100	44	100	40	57	77	48	73	50	50	100	68		67	50	80	100	56	100	100	100	50	20	33	100	67		100	100		63
10-20		38	67	67	26	39	11	50	57	25		56		60	43	15	36	18	41	50		32	100	33	50	20		44					60	33		21	100			100	31
20-50		8		33				25									8	9	9																	8					3
>50							11									8	4															50	20	33		4					2
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.15. Summary Tables for Vegetation Types: Bare Ground.

BARE GROUND COVER (%)	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded																	1																									1
<10					1	1			1		1	1						1				1				2									3					12
10-20	1				3	1			1	2		1	1		1		1		1			4					1					1			3					22
20-50			1		8	16	1	1		3		2	2		1	2	5	1	3	1		5	1		2	2		1		1					4	1				64
>50	1	13	2	3	26	13	8	3	5	3		5	5	5	5	11	18	9	18	5	4	12	1	3		1	1	7	5	6	6	2	4	3	1	14		1	1	1	231
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded																	4																									0
<10					3	3			14		100	11						9				5				40									13					4
10-20	50				8	3			14	25		11	13		14		4		5			18					11					20			13					7
20-50			33		21	52	11	25		38		22	25		14	15	20	9	14	17		23	50		100	40		11		14					17	100				19
>50	50	100	67	100	68	42	89	75	71	38		56	63	100	71	85	72	82	82	83	100	55	50	100		20	100	78	100	86	100	100	80	100	100	58		100	100	100	70
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.16. Summary Tables for Vegetation Types: Surface Capping.

EXTENT OF SURFACE CAPPING	VEGETATION TYPES																																										
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded										1							1			1		1																				4
None	2	13	3	3	36	31	9	4	6	7	1	8	6	4	7	6	10	9	20	4	3	21	2	3	2	4	1	7	5	7	6	2	5	3	1	20	1	1	1	1	285
Local					2				1			1	2	1		7	14	2	2	1	1					1		2								3					40
Widespread																																				1					1
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded										13							4			17		5																				1
None	100	100	100	100	95	100	100	100	86	88	100	89	75	80	100	46	40	82	91	67	75	95	100	100	100	80	100	78	100	100	100	100	100	100	100	83	100	100	100	100	86
Local					5				14			11	25	20		54	56	18	9	17	25					20		22								13					12
Widespread																																				4					0
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.17. Summary Tables for Vegetation Types: Sheet Erosion.

EXTENT OF SHEET EROSION	VEGETATION TYPES																																										
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded										1							1																									2
None	2	12	3	3	38	31	8	4	6	7	1	9	5	3	7	8	11	6	19	4	4	19	2	3	2	4		8	4	7	6	2	3	1		20	1	1	1	1	276
Local		1					1		1				3	2		5	8	5	2	2		3				1	1	1	1				2	1	1	4					45
Widespread																	5		1															1							7
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded										13							4																									1
None	100	92	100	100	100	100	89	100	86	88	100	100	63	60	100	62	44	55	86	67	100	86	100	100	100	80		89	80	100	100	100	60	33		83	100	100	100	100	84
Local		8					11		14				38	40		38	32	45	9	33		14				20	100	11	20				40	33	100	17					14
Widespread																	20		5															33							2
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.18. Summary Tables for Vegetation Types: Gully Erosion.

EXTENT OF GULLY EROSION	VEGETATION TYPES																																										
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded							1			1							2																									4
None	2	13	3	3	38	31	8	4	5	7	1	9	8	5	7	11	21	7	20	5	4	22	2	3	2	5		9	5	7	6	2	3	1	1	23	1	1	1	1	307
Local									2							2	1	4	1	1													2	1		1					15
Widespread																	1		1								1						1								4
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded							11			13							8																									1
None	100	100	100	100	100	100	89	100	71	88	100	100	100	100	100	85	84	64	91	83	100	100	100	100	100	100		100	100	100	100	100	60	33	100	96	100	100	100	100	93
Local									29							15	4	36	5	17													40	33		4					5
Widespread																	4		5								100							33							1
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.19. Summary Tables for Vegetation Types: Fire.

EVIDENCE OF BURNING	VEGETATION TYPES																																										
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded						2																						1		1				1							5
None		2		1	1				3	5	1		1	3		1	9		2	2	1	1						1		3	1	1			8					47
Low	1	8	2	2	30	15	2	4	2	2		6	5	2	7	11	12	7	19	3	2	13	2	3	1	4	1	6	4	3	3		3	2	1	16	1	1	1	1	208
Medium	1	1	1		3	5	3		1	1		2	2			1	4	3	1	1	1	7			1	1		2		2		1									45
High		2			4	9	4		1			1						1				1								1			1								25
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded						6																						11		14				33							2
None		15		33	3				43	63	100		13	60		8	36		9	33	25	5							20		50	50	20			33					14
Low	50	62	67	67	79	48	22	100	29	25		67	63	40	100	85	48	64	86	50	50	59	100	100	50	80	100	67	80	43	50		60	67	100	67	100	100	100	100	63
Medium	50	8	33		8	16	33		14	13		22	25			8	16	27	5	17	25	32			50	20		22		29		50									14
High		15			11	29	44		14			11						9				5								14			20								8
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.20. Summary Tables for Vegetation Types: Grazing/Browsing.

EVIDENCE OF GRAZING/ BROWSING	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded						1						1	1									4		2			1	2		1											13
None																																1								1
Low		8	2	1	9	21	4	1	3	3		2	1	3	6	4	13	5	6	1		2				2		5	2	4	3	1	3	3		4	1	1			124
Medium	2	2	1	2	24	8	3	1	3	5	1	4	2	2	1	4	6	5	9	3		6	2	1	1	2		2	2		3	1	1			5				1	115
High		3			5	1	2	2	1			2	4			5	6	1	7	2	4	10			1	1			1	2					1	15			1		77
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded						3						11	13									18		67			100	22		14											4
None																																20									0
Low		62	67	33	24	68	44	25	43	38		22	13	60	86	31	52	45	27	17		9				40		56	40	57	50	50	60	100		17	100	100			38
Medium	100	15	33	67	63	26	33	25	43	63	100	44	25	40	14	31	24	45	41	50		27	100	33	50	40		22	40		50	50	20			21				100	35
High		23			13	3	22	50	14			22	50			38	24	9	32	33	100	45			50	20			20	29					100	63			100		23
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.21. Summary Tables for Vegetation Types: Destruction of Trees.

EVIDENCE OF DESTRUCTION OF TREES	VEGETATION TYPES																																									
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded						1																																			1
None																																								0
Low		1		1	3	3						1		1	1		11	2	2	1		1		1		2			1					1		3					36
Medium	1	2			8	3		2		3			1	2	1	1	6	3	6	2							1	3					3			4		1			53
High	1	10	3	2	27	24	9	2	7	5	1	8	7	2	5	12	8	6	14	3	4	21	2	2	2	3		6	4	7	6	2	2	2	1	17	1		1	1	240
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Not recorded						3																																			0
None																																								0
Low		8		33	8	10						11		20	14		44	18	9	17		5		33		40			20					33		13					11
Medium	50	15			21	10		50		38			13	40	14	8	24	27	27	33							100	33				60			17		100			16
High	50	77	100	67	71	77	100	50	100	63	100	89	88	40	71	92	32	55	64	50	100	95	100	67	100	60		67	80	100	100	100	40	67	100	71	100		100	100	73
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 10.6.22. Summary Tables for Vegetation Types: Overall State of Vegetation.

OVERALL STATE OF VEGETATION	VEGETATION TYPES																																								
COUNTS	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Undisturbed																																								0
Slightly disturbed				1													1	1				1													2					6
Moderately disturbed	1	3					1	2	1	5			1	1		2	9	2	6	2				1		1		2		1			3	1		4		1			50
Heavily disturbed	1	10	3	2	38	31	8	2	6	3	1	9	7	4	7	11	15	8	16	4	4	21	2	2	2	4	1	7	5	6	6	2	2	2	1	18	1		1	1	274
Total	**2**	**13**	**3**	**3**	**38**	**31**	**9**	**4**	**7**	**8**	**1**	**9**	**8**	**5**	**7**	**13**	**25**	**11**	**22**	**6**	**4**	**22**	**2**	**3**	**2**	**5**	**1**	**9**	**5**	**7**	**6**	**2**	**5**	**3**	**1**	**24**	**1**	**1**	**1**	**1**	**330**
PERCENTAGES	**0**	**1.1**	**1.1.1**	**1.1.2**	**1.2**	**1.3**	**2.1**	**2.2**	**2.3**	**3.1**	**3.1.1**	**4.1**	**4.2**	**4.3**	**4.4**	**4.5**	**4.6**	**4.6.1**	**4.7**	**4.8**	**4.9**	**5.1**	**5.1.1**	**5.2**	**5.3**	**6.1**	**6.1.1**	**7.1**	**7.2**	**8.1**	**8.2**	**8.2.1**	**8.3**	**8.4**	**8.4.1**	**9.1**	**10.1**	**10.2**	**11.1**	**11.2**	**TOTAL**
Undisturbed																																								0
Slightly disturbed				33													4	9				5													8					2
Moderately disturbed	50	23					11	50	14	63			13	20		15	36	18	27	33				33		20		22		14			60	33		17		100			15
Heavily disturbed	50	77	100	67	100	100	89	50	86	38	100	100	88	80	100	85	60	73	73	67	100	95	100	67	100	80	100	78	100	86	100	100	40	67	100	75	100		100	100	83
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

10.7 Additional Electronic Data

a. Access database

b. (data for summary tables)

c. Photographs related to each sample

d. Georeferenced photos

e. Word document comprising species lists per plot

f. Verification data