RESOURCE UTILISATION OF THE CHACMA BABOON IN DIFFERENT VEGETATION TYPES IN NORTH-EASTERN MOUNTAIN SOUR VELD, BLYDE CANYON NATURE RESERVE.

BY

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RESEARCH DISSERTATION

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PREFACE

Baboons are important components of ecosystems and are often looked upon as the cause of problems when ecosystems deteriorate. This has resulted in large numbers of baboons being removed from their habitats without taking other environmental factors and their role in ecosystem functioning into consideration. When one component of an ecosystem is removed it results in a domino effect that could lead to further deterioration of that system, sometimes with catastrophic consequences (Thompson, 1992).

ACKNOWLEDGEMENTS

The Mpumalanga Parks Board who allowed the research to be conducted on the Blyde Canyon Nature Reserve and colleagues from the terrestrial section at Lydenburg who assisted with the identification of the plant specimens. Global Forest Products for funding and the use and assistance of staff in the GIS laboratory in Sabie. If it were not for the patience of my supervisors Prof Brown, Henzi & Barret I would not have finished. Two people in my life that stood by me, helped me through difficult times, and made it possible for me to complete my thesis, Bevvie and Anemien.

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ABSTRACT

The Blyde Canyon Nature reserve displays its natural beauty for most National and International visitors all over the World.

The region is renowned for its high rainfall and misty weather, which enhances the natural beauty of the area.
Because of the mist belt effect, the area is one of the largest commercial forestry areas in South Africa. Baboons also seek after the topography and vegetation type (Northeastern mountain sourveld) that is typical of this area and numerous baboon troops occur in this region. This combination is often the cause of conflict between baboons and humans.

The need arise for these baboons to be studied and managed as a component of this very important ecosystem.
The main aims of the study were firstly to identify a natural ranging baboon troop, to habituate them and gather data regarding home range sizes, troop sizes, densities and seasonal food selection and secondly to give a detailed habitat description and vegetation map of the troop's home range.
The baboon activity data was collected in 15-minute intervals over a one year period on a troop at Bourke's Luck. This included all activities such as walking, social, foraging, and resting. The food parts selected as well as the species foraged on was identified. Numerous statistical methods were used on the baboon data such as; the Shapiro Wilk test, Spearman rank-order correlation, ANOVA, and the Kolmogarov-Smirnov two sample test.
There was a positive correlation between home range areas and troop sizes and the baboons preferred certain habitats above others during different seasons.

To give a detailed habitat description of the troop's home range, 50 sample plots was stratified-randomly distributed in order to include all the different stratification units. a TWINSPAN classification, refined by Braun-Blanquet procedures was carried out on the Bourke's Luck section that included the baboons home range. 13 Plant communities, which can be grouped into 7 major community types were identified.

This study resulted in the ecological interpretation of baboon activities related to the ecological interpretation of the vegetation in the baboon troop's home range

Key words: Blyde Canyon Nature Reserve, Chacma Baboons, North Eastern Mountain Sourveld, Braun-Blanquet, Twinspan.

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CHAPTER 1

INTRODUCTION

The International Union for the Conservation of Nature and Natural Resources (IUCN), defined conservation as “the management of human use of the biosphere so that it may yield the greatest sustained benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations.” (WCS, 1980)

The conservation of natural ecosystems and their plant and animal inhabitants has a long and complicated history. Modern conservation attitudes and practices have evolved largely within the context of western society, and have been moulded definitively by the major political, economic, and intellectual revolutions that western society has experienced. These forces continue to shape the practice of conservation worldwide. (Brown & Brand, 2004)

Conservation has also developed from an exclusive concern with the protection of animals to the protection of entire ecosystems in which all living organisms have a legitimate role to play. Increasing concerns about the state of the global environment have led to the development of a concern, not only with parks, but also with the environment as a whole, which includes the human environment. Concern for the quality of the environment has its roots in earlier times when the survival of the human race was dependent on close interaction with the environment. The relationship became increasingly threatened as the agricultural and industrial revolutions progressed. In many areas where advanced technology, health services and consumer demands have been introduced to developing rural and overcrowded urban communities, this relationship between human and environment has become increasingly strained. (Hunter, 1996; Cunningham, 1991) The conflict between humans and baboons provides a southern African example of this increased conflict between humans and the environment.

Modern baboons (*Papio hamadryas*) emerged in southern Africa approximately two million years ago and have subsequently diverged into five nominal subspecies, of which the chacma baboon (*Papio hamadryas ursinus*) is one. (Newman *et al.,* 2004) (Fig.1.1)

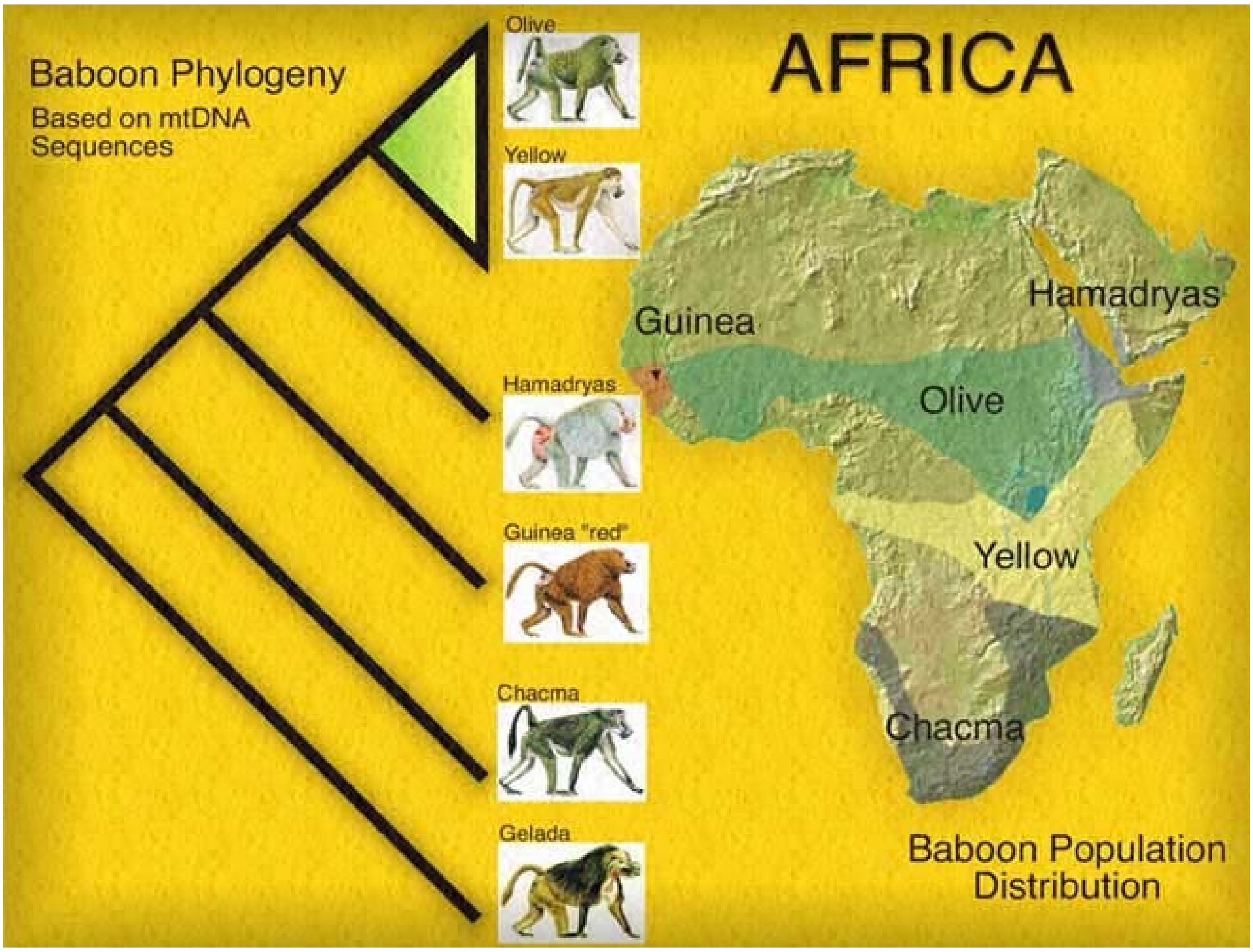

Figure 1.1: The distribution of the five nominal subspecies of baboons throughout Africa, of which the chacma baboon (*Papio hamadryas ursinus*) is one. (Newman *et al.,* 2004)

Baboons are highly intelligent and ecologically flexible animals with attributes that allow them to exploit diverse habitats. They forage in diverse habitat types on a wide variety of plant species, insects, reptiles and often mammals. Baboons are mainly vegetarian. However, they are able to adapt to any environment and to utilise whatever food is available. (De Vore & Hall, 1965) Chacma baboons occupy a broader range of habitats than other subspecies and are important constituents of local ecosystems. (Henzi & Barrett, 2003) A partial consequence of their dietary flexibility is that they can and do exploit human habitats, often causing damage to crops and forest plantations as well as to human dwellings. This has led to baboons being regarded as problem animals that should be eradicated from these areas.

In provincial legislation, the chacma baboon is not classified as a game species, and can be shot without a permit. (Mpumalanga Provincial Legislation, 1998) This perception of and attitude toward baboons gives many conservationists cause for concern. The environment consists of complex ecosystems in which there is a balance in the interactions of the living and non-living components. (McNaughton, 1989)

Baboons fulfil an important role in the broader ecosystems within which they function. Eradication of these animals would have a negative effect on the broader environment since they are important in the control of insect populations and the dispersion of plant seeds and are a prime source of food for leopards. According to Knight & Siegfried (1983) seed dispersal by mammals is fundamental to maintaining the structure and function of various terrestrial ecosystems. Primates are important agents of seed dispersal because their diet consists largely of fruit. (Howe, 1986; Skinner, 1990; Stuart & Stuart, 1992) Because baboons are highly mobile and their diet consists largely of a variety of fruit species, they are potentially prime agents for the dispersal of woody plant species in natural areas and, because of their mobility, they are not confined to specific game areas like syntopic ungulates. This mobility contributes to seed dispersal. (Slater & du Toit, 2001)

Baboons are highly mobile within individual home ranges, which vary in size between baboon troops, depending on the food available within the various plant communities occurring in that area. Each habitat represents it own unique mosaic of plant species, which enables baboons to utilise their home ranges by employing foraging strategies. Thus different plant communities present food to baboons at various times of the year, resulting in the baboons exploiting these habitats when suitable food is available. They generally occupy all of the plant communities within their home ranges. This makes a wide range of food and other resources, such as water and sleeping sites, available to them throughout the year. (Henzi *et al.*, 1992) Studies done in other related habitats within the southern African subcontinent have shown that their home ranges can differ within plant communities and indicate seasonal differences related to food availability as well as troop size and structure. (Henzi *et al*., 1997)

Currently, most nature conservation authorities and reserves have no formal management plans for baboons. This can be attributed to the limited knowledge of these animals and their effect on various ecosystems. Knowledge of the dietary requirements of these animals and the plant communities within which their food sources occur would assist in making decisions on the implementation of such a management programme. It is therefore necessary to understand the dietary requirements of baboons to predict areas of conflict with human interests and to contextualise any problems that arise, and manage the animals with minimum interference. If this is done in advance, it will reduce the risk of baboons being forced to leave their natural habitat in search of food.

Thus, as a first step to implementing a conservation policy to manage these animals, it is necessary to have some understanding of their exploitation of natural habitats in areas where they do cause problems.

Since chacma baboons occur throughout the southern African subregion, it is important that applied behavioural ecological studies should be conducted in various habitats to determine their impact on the environment and surrounding areas. This will enable the managers of reserves and forest plantations to formulate scientifically based management plans for these animals.

Various authors have studied the ecology of chacma baboons in atypical habitats, namely: the Drakensberg mountains of Natal (Henzi *et al*., 1992; Henzi, 1995; Watson, 1985); the southern woodlands of Natal in the Mkuzi Game Reserve (Gaynor, 1994); the fynbos and coastal vegetation in the south-western Cape at the Cape Point Nature Reserve (Hall 1962 & 1963; Davidge 1977 & 1978), the arid fynbos in the Mountain Zebra National Park (Dunbar, 1992) as well as in the arid Kuiseb Canyon in the Namib dessert (Hamilton *et al.,* 1976). However, no such study has been done for the Blyde Canyon Nature Reserve (BCNR) (Fig. 1.2).

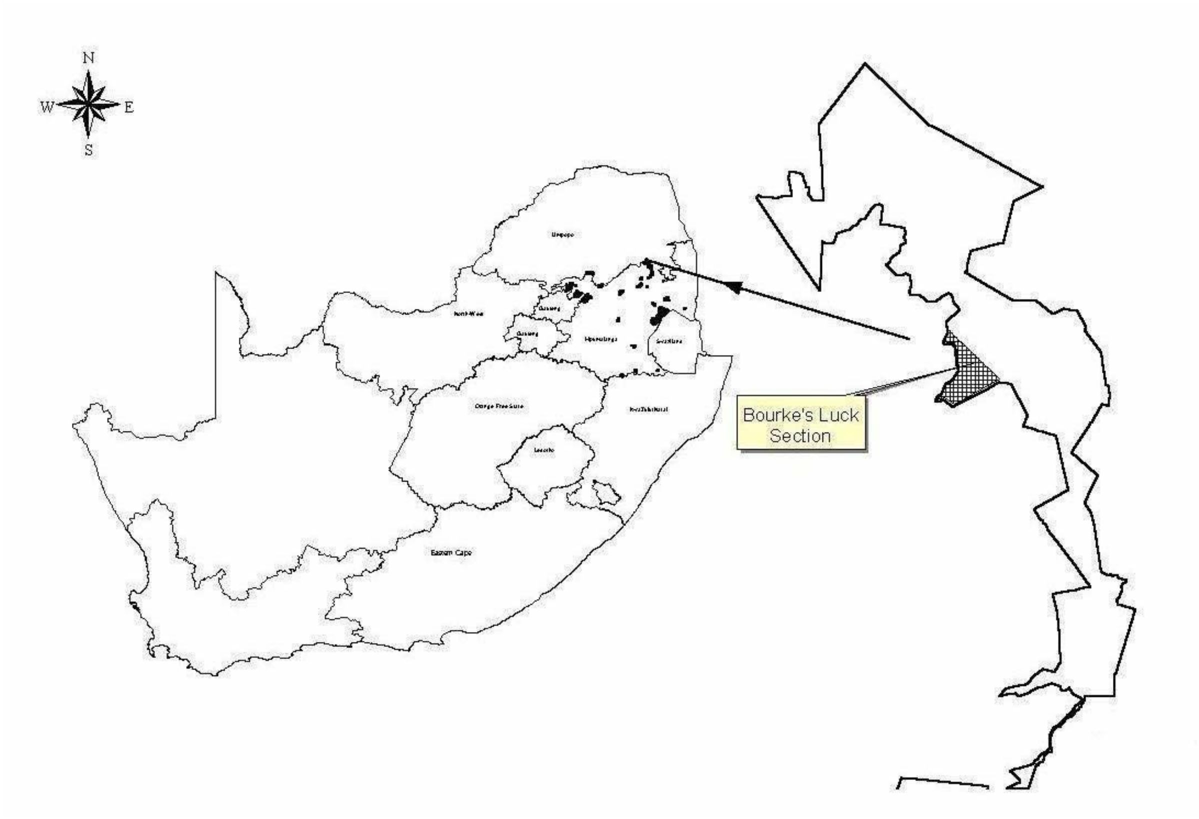

Figure 1.2: A map of South Africa, showing the location of the Blyde Canyon Nature Reserve (BCNR), including the Bourke's Luck section, the focus of this study.

No other studies have thus far been conducted on baboons in the region and this is the first study to be conducted in the Mpumalanga province of South Africa. The study area comprises the Wolkberg centre of endemism (Matthews *et al*., 1994) on the eastern escarpment section of Mpumalanga.

The scenic BCNR with its varied habitats – from undulating grasslands to deep incised valleys, to indigenous montane forests – hosts a number of baboon troops. The BCNR is bio-diverse, with many rare and endemic plant species occurring within its boundaries. (Lotter, 2002) It is therefore important to understand the ecology of chacma baboons in this complex mosaic of vegetation types. The BCNR covers a total area of 26 818 ha, with approximately 80% of the this being neighboured by commercial forestry. These commercial forestry areas cover millions of hectares and have a significant impact on the natural environment, such as reduced stream flow, erosion and an altered fire regime. (Macdonald & Richardson, 1986) Forestry practices cause a decline in plant species richness as well as animal species and the forestry areas are therefore not as rich in plant diversity as the adjoining natural areas.

The future of nature conservation lies in the systematic planning and co-ordination of conservation activities (Anon, 1985) as well as the development of scientifically sound management plans for nature reserves and other conservation areas. The ideals for management of nature reserves will have to be dynamic, changing as the needs of society dictate. (Somers, 1992) One of the primary goals of nature conservation should be to preserve diversity and the persistence of species. (Walker, 1989)

In order to make suitable and scientifically based management recommendations for baboons in the BCNR it is important that their habitat (plant communities), food selection and social interactions be studied. No policies regarding nature conservation can be drawn up without knowing what is to be conserved, why it has to be conserved or its present status. (Anon, 1985)

The study of the vegetation (plant communities) of the home range forms the basis on which any study of the ecology, social interaction and dietary requirements of any animal is based.

OBJECTIVES

The objectives of this study are to:

- determine home range size and usage in the Bourke’s Luck section of a single baboon troop;
- give a detailed habitat description and vegetation map of the home range of this baboon troop;
- describe the social behaviour of this baboon troop;
- determine the seasonal food selection of the troop; and
- propose management recommendations for baboons in the area.

CONTENTS OF THE THESIS

Chapter 1: A general introduction to the ecology of the chacma baboon as well as the objectives of the study.

Chapter 2: An overview of the study area is given with particular reference to the location, climate, geology, vegetation and management of the Blyde Canyon Nature Reserve (BCNR)

Chapter 3: A detailed description of the methodology followed with this study as well as the data analysis.

Chapter 4: Results of the vegetation description of the Bourke's Luck section of the BCNR.

Chapter 5: Results of existing baboon troops in the BCNR as well as ranging data and habitat use of the Bourke's Luck Canyon Troop (BLCT)

Chapter 6: Results of the diet selection of the BLCT.

Chapter 7: Conclusion.

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CHAPTER 2

STUDY AREA

INTRODUCTION

The Blyde Canyon Nature Reserve (BCNR) was originally proclaimed in 1965 for its outstanding natural beauty. In March 1997, the Mpumalanga Parks Board took over the management of the BCNR. The escarpment area has been identified as an important centre for endemism. (Fourie *et al*., 1988, Matthews *et al*., 1993) In particular; the BCNR was specifically identified as an important conservation area in this respect. (Bredenkamp *et al.*, 1996)

The BCNR has the highest plant diversity within the Mpumalanga province and is host to numerous endemic and highly restricted plant species. A total of 12% of the Wolkberg Centre of Plant Endemism (WCPE) is formally protected within Mpumalanga, with the BCNR critical in the conservation of the Blyde Subcentre of Plant Endemism. The scenic beauty and high biodiversity of the reserve, with its habitats varying from undulating grasslands, to deep incised valleys, to indigenous montane forests, makes the reserve an important tourist attraction. It also serves as an important education centre for environmental education in the region.

LOCATION AND SIZE

The BCNR is 26 818 ha in extent and is situated on the northern and western boundaries of the town of Graskop (Fig. 1.2) The BCNR is located along the Great Escarpment in the Mpumalanga province of South Africa at latitude 24º 27'-25º 56' and longitude 30º 44'-30º 55'

CLIMATE

Although the reserve is situated in the summer rainfall area of South Africa, rainfall varies widely along the more than 50-km long north-south axis. Swadini, which is situated below the escarpment in the north of the reserve, receives an average of 605 mm of rain annually.

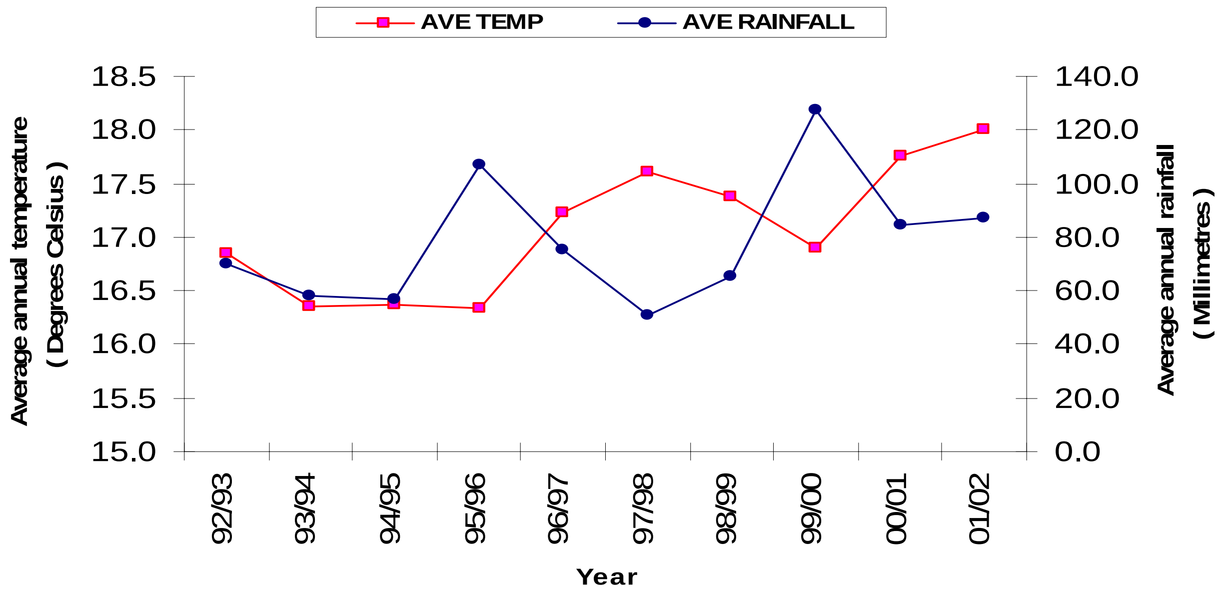

Figure 2.1: The average annual rainfall and temperature of the Bourke's Luck section of the BCNR for ten years (1992-2002)

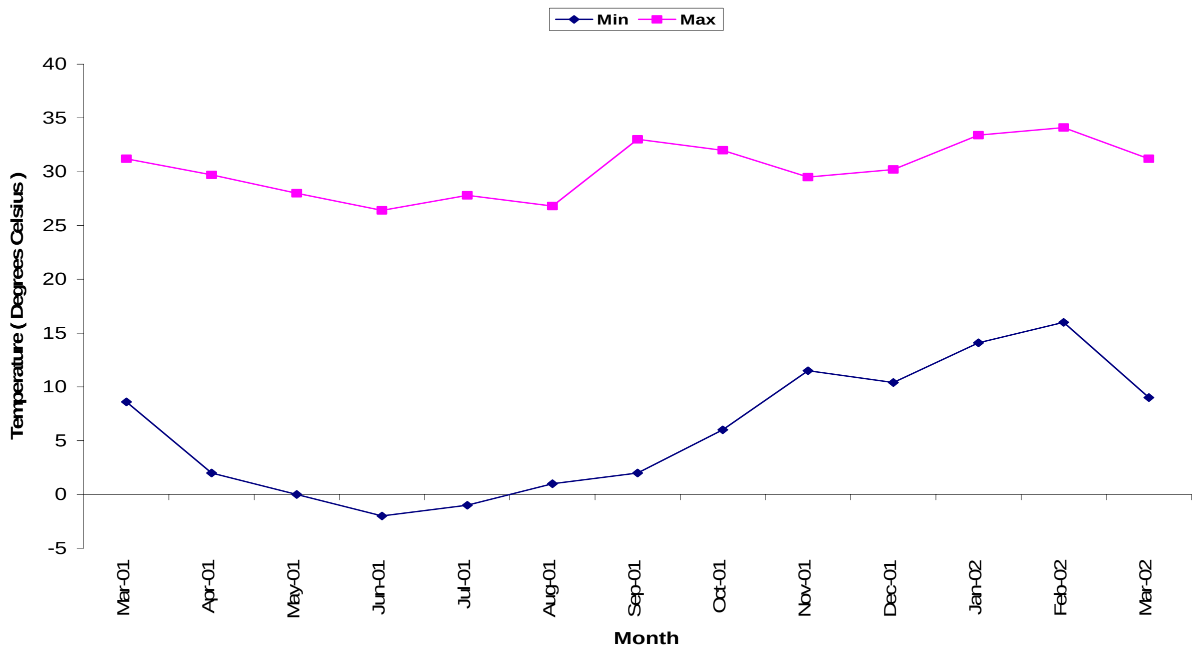

Figure 2.2: The monthly minimum and maximum temperatures of the Bourke's Luck section of the BCNR during the study period (March 2001-March 2002)

The Bourke's Luck section in the centre receives an average of 857 mm and God's Window in the south up to 2 774 mm per year. The average rainfall for the past 10 years was between 700 and 1 400 mm. (Fig. 2.1) Average daily temperatures for Swadini range between 17,7 ºC and 26,1 ºC , Bourke's Luck between 11,5 ºC and 21,3 ºC and God's Window between 10,9 ºC and 18,6 ºC. (Fig. 2.1) The temperatures during the winters can be below zero (0 ºC) and those in the summers above 30 ºC. (Fig. 2.2)

TOPOGRAPHY

The topography of the BCNR ranges from sheer cliffs dropping off at perpendicular angles to relatively flat plateaus and valleys. The area is known as the Lowveld Escarpment. Elevation ranges from 580 m to over 1 900 m above sea level. (Fig. 2.6) The most striking topographical features are the Blyde River Canyon, the third largest vegetated canyon in the world, which stretches for 21 km from Bourke's Luck in the south to the Blyde dam in the north. (Fig. 2.5)

LAND TYPES, GEOLOGY AND PEDOLOGY

Land Types

According to the Land Type Survey Staff (1989), "A land type denotes an area that can be shown at 1:250 000 scale and that displays a marked degree of uniformity with respect to terrain form, soil pattern and climate." A remarkable association between the major communities and the various land types has been observed in other studies. (Kooij *et al.,* 1990; Bezuidenhout, 1993; Eckhart, 1993; Brown, 1997; Brown & Bezuidenhout, 2000)

Two land types, namely Fa and Ic, occur in the Bourke's Luck section of the BCNR as indicated in the terrain form sketch (Fig. 2.3) The land type unit Fa refers to red apedal, medium sandy loam – well drained soil which is shallower than 1 000 mm. The overall terrain type is relatively flat with more than 60% of the surface having a slope of less than 5%. The predominant geology of this land type is quartzite, conglomerate, shale and basalt of the Black Reef formation, Transvaal sequence. The foot slopes are rocky with an average rock cover of 19%, while the dominant soil type, Hutton, is found on the crest of the terrain unit. (Land Survey Staff, 1989)

The Ic land type refers to land types with exposed rocks covering between 60 and 80% of the area. The soil varies from dark brown orthic soils to loamy fine sand and is very shallow (less than 100 mm). The dominant soil type is Mispah, present on the midslopes. The geology consists of shale, quartzite, conglomerate and basalt of the Wolkberg group, Transvaal sequence. (Land Survey Staff, 1989)

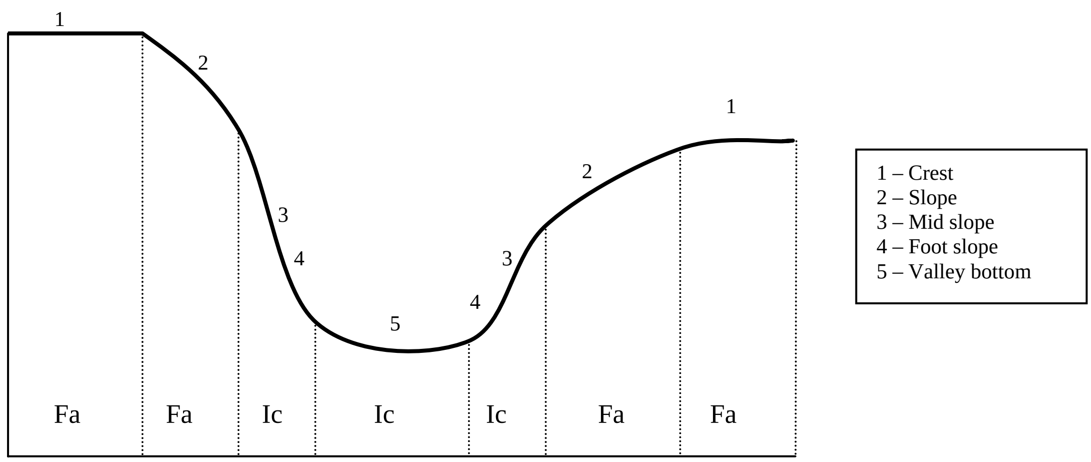

Figure 2.3: A terrain form sketch indicating the various land types of the study area.

Geology and pedology

Four main geological systems are found in the area, with some of these being intersected by later diabase intrusions. However, the dominant geological formation exposed on almost the entire surface of the BCNR is quartzite. (Fig. 2.4)

The entire area represents the eastern rim of the Bushveld Igneous Complex of the Central Transvaal. The majority of the variation in topography of the escarpment is determined by the response of the various underlying geological formations to weathering. (Bosch, 1992)

The Wolkberg Group

These rocks rest on the Swazian floor rocks (Archaean basement = 3 500+ million years old), forming the base of the Escarpment. The Wolkberg group can be divided into six formations, which are, from the base: (Bosch, 1992)

Sekororo formation**:**
Mainly very coarse-grained clastic sediment with small amount of fine-grained material, probably deposited on alluvial fans.

Abel Erasmus formation
Lava (basalt), pyroclasts and sedimentary rock with stromatolites, the latter has grown in still shallow pools.

Schelem formation
Mainly fine-grained sediment in clay and sandy layers, probably part of an alluvial fan and the cyclic beds probably represent a swamp or mud plain.

Selati formation
Large amounts of fine-grained material with a relatively thick succession of upwards coarsening sandstone. This formation has three members namely:

Anlage member
Massive carbonaceous black mudstone with not many sedimentary structures.

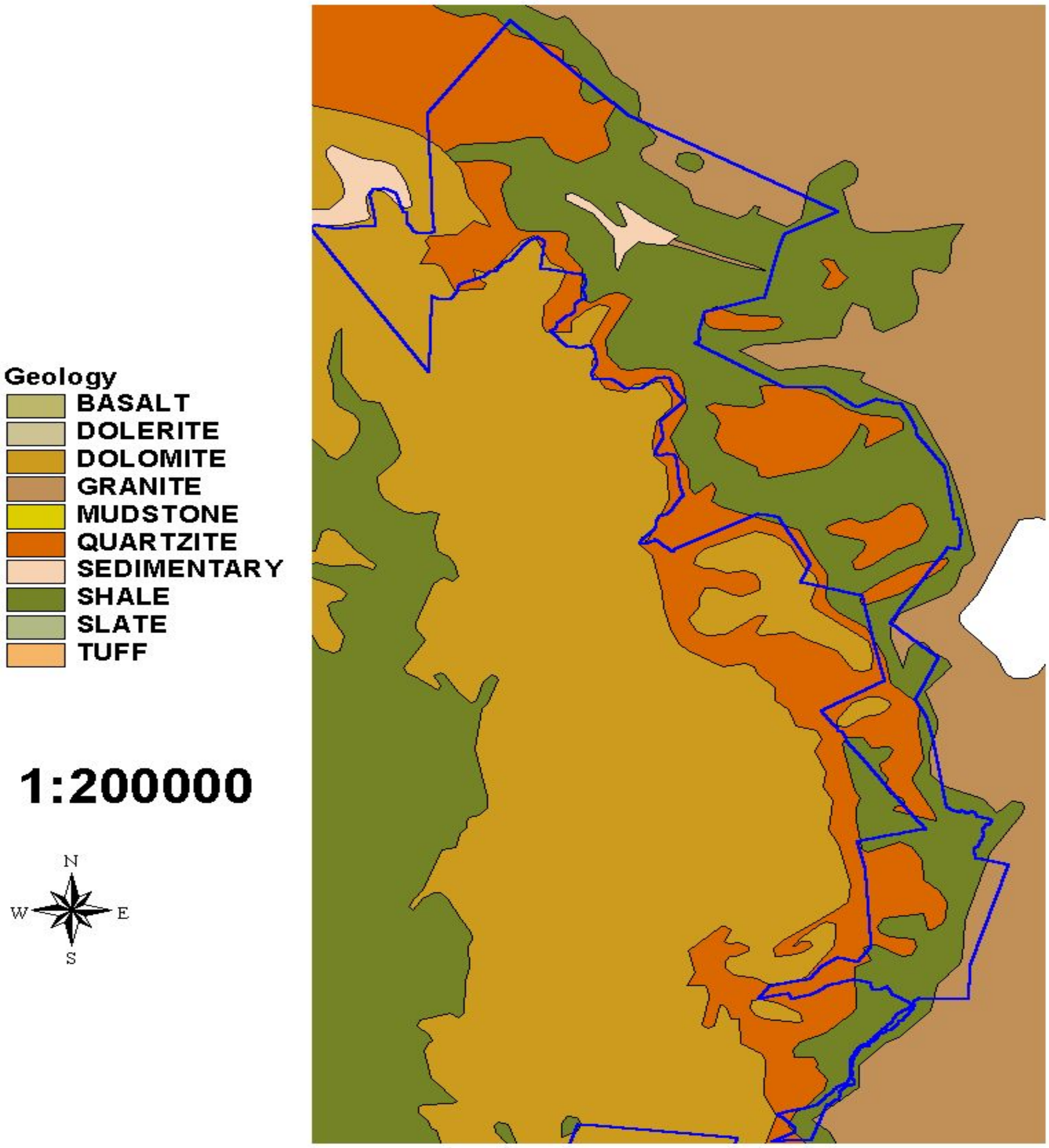

Figure 2.4: A 1:20 000 geological map showing the broader geology types of the BCNR (Bronkhorst, 2001)

Manoutsa member

Clayey sandstone with a few layers of mudstone, which becomes progressively cleaner towards the top. This member is characteristically mega-crosslayered. Each layer can be a few kilometres long and several metres thick. Layers are also upwardly graded from clayey to more sandy.

Mametjas member

Carbonaceous and calcareous shale, dolomite and mudstone layers. Mud cracks, stream and wave ripples occur (Bosch, 1992)

<u>Mabin formation</u>

Relatively clean, well sorted sandstone and slightly more clayey sandstone.

<u>Sadowa formation</u>

Calcareous and clayey sandstone, rhythmic layered dolomite and carbonaceous shale and sometimes dolomite and/or ferricrete.

<u>Black reef formation</u>

This formation follows conformably on the Sadowa Formation in the north of the area. Towards the south-east of the area, in the vicinity of Mariepskop and Bourke's Luck, the formation cuts the underlying older formation transversely.

This formation varies from 0-500 m thick and consists of a succession of very clean quartzite with, in places, lenses and layers of pebbles, and also, in places, a conglomerate of the above combination occurring at the base. Shale is present, especially near the top, on the contact zone with the overlying dolomite. This formation is very resistant to weathering, especially the clean quartzite, and is largely responsible for the shape of peaks, cliffs and gorges as well as the many interesting shapes of the weathered rock outcrops found throughout the area.

The Black Reef Formation is largely responsible for the formation of the Great Escarpment of the Drakensberg, incised by the Olifants and Blyde Rivers. (Bosch, 1992)

The Chuniespoort Group

This group is predominantly chemical in origin and overlies the Black Reef Quartzite Formation. It is mainly made up of dolomite, as well as limestone, chert. Near contact areas with the Black Reef Quartzite layers, carbonaceous shale and quartzite occur. (Oaktree formation). This group is subdivided, with the Malmani Subgroup being of importance here.

Figure 2.5: A photo of a section of the Blyde River Canyon close to Bourke's Luck.

The Malmani Subgroup can be divided into five formations on the basis of chert content and the presence or absence of types of algal structures in the dolomite.

The occurrence of cave and tufa, the latter being found along many of the steams flowing over or near to this rock type, is characteristic of the area. Dolomite rock outcrops are not usually found in the high rainfall areas owing to the high solubility of the limestone. Where rock outcrops are found, mostly in the lower rainfall areas, the typical wrinkled, corrugated texture of its surface can be seen, resembling that of an elephant's hide, which has given rise to the popular name of "Olifantsklip". (Bosch, 1992)

The Pretoria group

This group, which overlies the Chuniespoort Group, is essentially made up of sedimentary rocks. It consists predominantly of shale and quartzite rock and varies from 900-1 600 m in thickness. The formation that is of importance here is the Timeball Hill Formation. This formation consists mainly of shale and mudstone, with zones of quartzite. The quartzite zones are more resistant to weathering, giving rise to the mountain peaks and ridges of this geological zone. This formation is an important part of the escarpment in the southern parts, but does not form part of the escarpment in the northerly areas. (Bosch, 1992)

Transvaal Diabase

The numerous diabase and other basic intrusions found mostly in the Pretoria Group are called the Transvaal Diabase. These intrusions are not found in the Wolkberg Group. Although scarce, they do occur in the in the Chuniespoort Group. (Bosch, 1992)

Quaternary deposits

Quaternary deposits in the study area include alluvial deposits and scree deposits. Alluvial deposits are found along most of the streams traversing the area. The deposits vary according to the geology of the runoff area, but silty and clayey deposits predominate. Prominent scree deposits, including alluvial fans, predominate in the escarpment mountain areas, were they can obscure the underlying geology. (Bosch, 1992)

The soil patterns of the area are very complex, being a result of the topography and the weathering of the various geological substrate types. However, sour soil patterns are commonly observed and are specifically related to the underlying quartzite rock type.

Large areas of exposed rock from mountain peaks, cliffs, ridges and of local resistant rock types are characteristic of the area and these areas are associated with shallow soil forms (lithosols), with the dominant soil forms being the Mispah and Glenrosa forms, as well as areas where virtually no soil occurs. (Matthews, 1991)

The valleys have deeper soils. The commonest soil forms are the Hutton, Clovelly, Champagne and Magwa forms. The deepest and most fertile soil occurs where dolomite (geological) rock formations occur. However, these are mainly restricted to the Stanley Bush Hill area in the south and very small portions of the Rietvlei and Steenveld sections in the north.

The fact that the area is situated in a high rainfall region has resulted in many of the soil forms showing signs of medium to high leaching as well as being acidic (an average pH of 4,7). (Land Type Survey Staff, 1989) The soil from the dolomite formation is the least acidic. (Deall *et al.,* 1989)

DRAINAGE

Three of Mpumalanga’s larger perennial rivers flow through the reserve, namely the Blyde, Treur and Ohrigstad rivers. The Blyde River flows for a distance of 26 kilometres and the Ohrigstad River for 11 kilometres through the reserve. The reserve is contains almost the entire upper catchment area of the Treur River. (Fig. 2.6)

VEGETATION

The greater part of the reserve comprises grassland identified by Acocks (1988) as north-eastern mountain sourveld, type No. 8, and by Low & Rebelo (1996) as north-eastern mountain grassland, type 43. Dense afro-montane forests cover the southern and eastern slopes of the reserve.

Other Acocks veldtypes represented on the reserve include mixed bushveld, sour mixed bushveld and arid lowveld (Fig. 2.7)

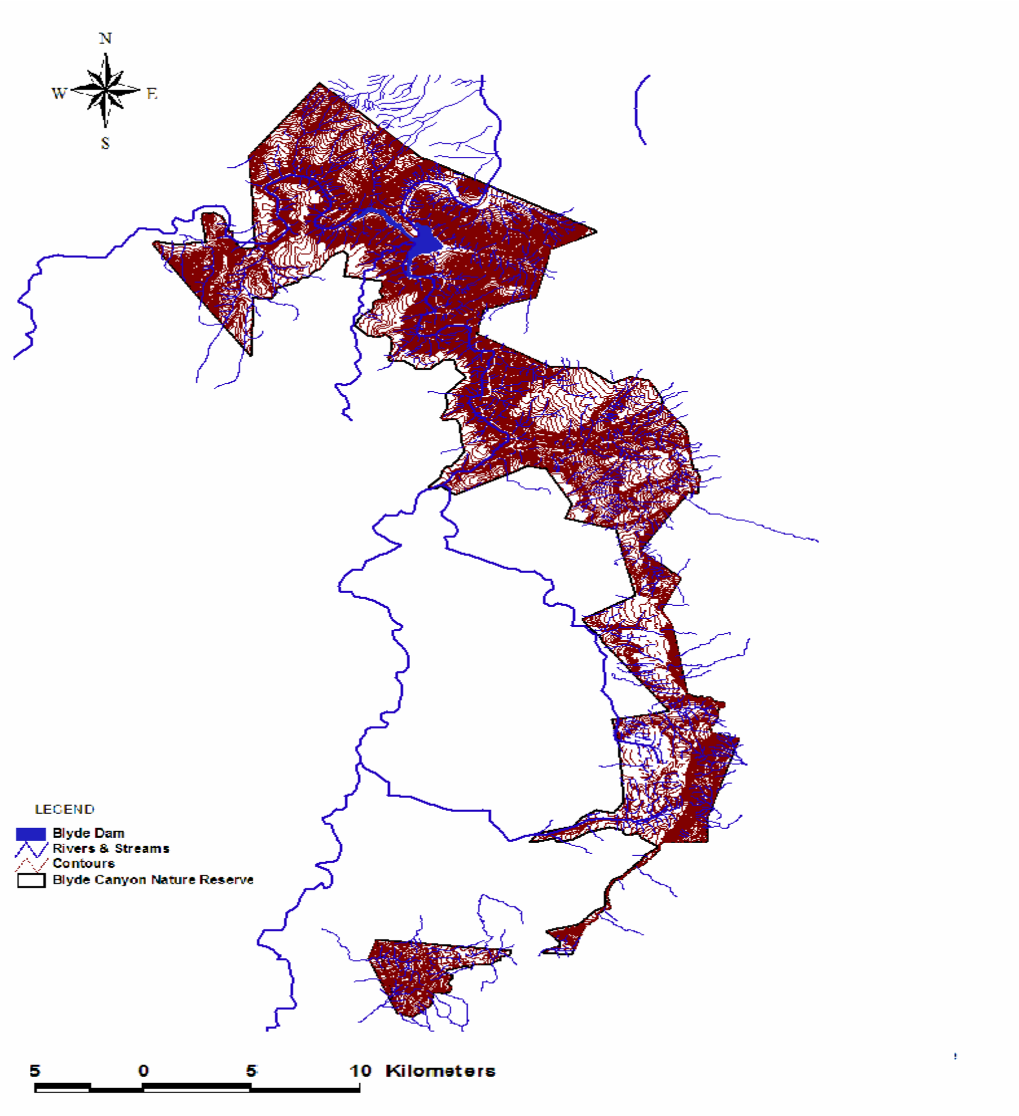

Figure 2.6: A 1:50 000 topographical map of the BCNR including the major rivers that flow through the reserve (Bronkhorst, 2001)

Plant communities

Within the previously mentioned veldtypes, a number of plant communities can be distinguished:

- *Englerophytum- Protea- Syzigium* grassland
- *Faurea saligna* grassland
- *Combretum* savanna
- *Terminalia sericia* savanna
- *Acacia tortilis* savanna
- *Pterocarpus – Englerophytum* savanna
- Rietvlei mixed bushveld

- *Combretum- Faurea* savanna
- *Faurea- Protea* grassland
- *Protea* grassland
- Mixed arid lowveld with *Acacia nigrescens*
- Scree slopes and riverine forest
- Grasslands of the north-eastern mountain sourveld
- Indigenous forests and rock formation communities.

These veld types are rich in plant species, with more than one thousand plant species recorded on the reserve. Among those, more than fifteen rare and endangered plant species occur within the boundaries of the reserve. These include *Aloe molesta, Angreacum chmaeanthus, Combretum edwardsii, Encephalartos cupidus, Erica revoluta, Erica rivularis, Gladiolus varius, Gladiolus vernus, Heamanthus paucilifolius, Hypericum roeperanum, Kotchya thymadora, Kniphopia triangularis, Leucospermum saxosum, Orbeanthus hardyi, Protea laetans, Protasparagus rigidus, Sterptocarpus decipiens, Watsonia tranvaalensis,* and *Warburgia salutaris.* (*Bronkhorst*, 2001)

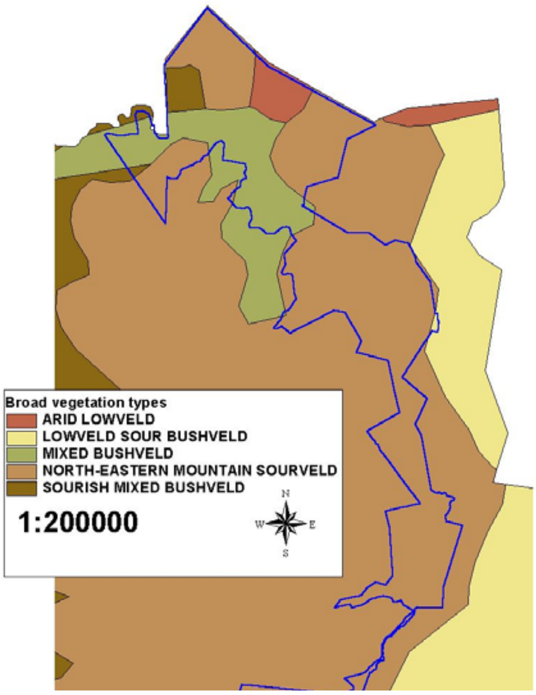

Figure 2.7: A 1:20 000 vegetation map showing the major veld types of the BCNR (Bronkhorst, 2001)

CENTRES OF ENDEMISM

Three of the world's centres of plant diversity lie within the eastern region of South Africa. Although the richness of the Cape flora has long been acknowledged, the Maputoland, Pondoland and Drakensberg Alpine regions were singled out in 1994 as areas of global botanical importance. The reason for this declaration lies in the region's high diversity and large numbers of endemic or threatened species with social, economic, cultural or scientific importance. (Pooley, 1998)

The escarpment area has been identified as an important centre of endemism (Fourie *et al.,* 1988, Matthews *et al.,* 1993), and the BCNR has been specifically identified as an important conservation area in this respect. (Bredenkamp *et al*., 1996)

The BCNR has the highest plant diversity within Mpumalanga and is host to numerous endemic and highly restricted plant species. The endemics form part of the greater Wolkberg Centre of Endemism that is divided up into the Blyde and Serala subcentres.

The Blyde subcentre covers a large area and incorporates the dolomite and quartzitic endemics, which are often found along a climatic gradient.

For example, one finds *Combretum petrophilum* growing along arid quartzitic outcrops; *Euclea dewinteri* prefers the slightly moist sandy soil around Bourke's Luck. *Streptocarpus decipiens* is found in relatively dry pockets of soil under quartzitic boulders in the mist-belt near Graskop, while *Gladiolus saxatilis* is only found on the moist side of cliffs in pockets of humus rich soils where the rainfall is usually above 2500 mm per annum. These are all quartzite endemics forming part of the Blyde subcentre of Endemism. Apart from these few taxa mentioned, a number of "*laetans'*" species have also been described: *Protea laetans, Rhoicissus laetans* and a still undescribed *Ozoro*a for which the name *Ozoroa laetans* has been proposed. The word laetans is Latin for “joyful” which is derived from the Afrikaans word Blyde (Lotter, 2002)

Wolkberg Centre of plant endemism (WCPE)

The WCPE is geologically comprised of the Black Reef Quartzitic Formation, Wolkberg Group and the dolomitic Chuniespoort Formation. Two sub centres are identified for the WCPE, based on the distribution of endemic/near-endemic plant taxa recorded for each of these areas (Matthews *et al*., 1993)

<u>Blyde Subcentre</u>

Occurs south of the Olifants River along the Mpumalanga Escarpment, with approximately 36 taxa strictly endemic to this sub centre.

<u>Serala Subcentre</u>

Occurs to the north of the Olifants River along the Limpopo Escarpment, with approximately 15 taxa strictly endemic to this sub centre.

Nearly all of the endemics are herbaceous and endemism is high within the Asteraceae, Lamiaceae, Iridaceae and Asphodelaceae. A total of 12% of the WCPE is formally protected within Mpumalanga, with the BCNR critical in the conservation of the Blyde Subcentre of Plant Endemism. Unfortunately, the WCPE is the most transformed centre of endemism, with 46% of the natural vegetation transformed. Afforestation has had the greatest impact on this centre, (22,2% declared afforested area) than any other in the world, hence the strong plea for the preservation of the entire Afromontane flora made by White (1981)

ALIEN PLANTS

The BCNR is situated within one of the country’s largest forestry areas and is the majority of the escarpment area of the reserve surrounded by forestry plants. These forestry areas consist mainly of alien plants: such as *Acacia mearnsii*, *Acacia* *melanoxylon, Pinus patula*, *Solanum mauritianum*, *Sesbania punicea*, *Jacaranda mimosifolia*, *Opuntia ficus-indica*, *Lantana camara* and numerous other alien plant species. These species is constantly invading and threatening the pristine natural beauty of the BCNR and is a well-organised alien plant programme of extreme importance.

INVENTORIES

Rare bird species breeding within the boundaries are blue swallow and bald Ibis. There are forty-seven mammal species, thirty-seven amphibian species, thirty-four indigenous fish species, one hundred and twenty five reptile species. One hundred and eleven genera out of thirty-nine families of spiders, seven genera of saw flies and one hundred and ninety five species of Lepidoptera have been recorded on the reserve. (Bronkhorst, 2001)

HISTORY OF UTILISATION

The oldest traces of human activities found on the BNR dates back to the Early Stone Age (150 000-30 000 years ago) These Stone Age humanoids lived entirely off the land as nomads who followed game movements.

Bushman paintings occur widely in the reserve and proof of their former presence exists at several sites of monochromatic rock paintings that have been discovered on the reserve.

In 1844 a group of Voortrekkers under leadership of Hendrik Potgieter, who explored the area to find a trade route to Delagoa Bay (Maputo today), named the Treur (River of Sorrow) and the Blyde rivers (River of Joy) during their expeditions.

During 1873-74, gold was discovered in most of the area around Sabie, Mac Mac and Pilgrim's Rest. Many of the mining trenches dug in the area since then are still visible, particularly in the southern section of the BCNR.

Many wagon trails, the scars of most of which still exist on the landscape, provided access to harvest trees from indigenous forests from 1880-1925. The harvesting of indigenous wood to support the mining industry also had a direct effect on forest vegetation.

The demand for timber resulted in wattle, pine and gum trees being imported to the area. Since 1904, the forestry industry has flourished in the area, with the first trees being planted on the farm Driekop near Graskop. During 1914, a railway line was completed from the town of Nelspruit to Graskop in order to support the forestry industry.

OLD DISTURBANCES

The major source of old disturbances in BCNR are related to past mining activities. This includes the Bourke's Luck mining complex and numerous narrow mining trenches and small mining operations spread throughout the area. These operations were particularly focused on the area toward the south and east of Bourke's Luck. These disturbed areas are normally infested with alien plants such as *Acacia mearnsii* and *Acacia melanoxylon.* Some of these disturbances have recovered over the last decade, but there is a visible change in the vegetation. (See Chapter 4)

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CHAPTER 3

MATERIALS AND METHODS

VEGETATION ECOLOGY

Sampling

The study area was stratified into physiognomic-physiographic units using 1:20000 stereo aerial photographs. To ensure that all variations in the vegetation were considered and sampled, 61 sample plots were located on a randomly stratified basis within the various units identified. (Bredenkamp, 1982; Bezuidenhout, 1993; Brown & Bredenkamp, 1994) Plot sizes were fixed at approximately 200 m^2 in accordance with Bredenkamp. (1982) The number of sample plots placed per unit was on a *pro rata* basis depending on the size of the unit delineated on the aerial photograph. Consequently, more plots were placed in the larger than the smaller units. Each sampling plot was marked on an aerial photograph and its co-ordinates noted with the use of a GPS.

Braun-Blanquet vegetation and habitat surveys were conducted in each of the sample plots by recording all plant species present. The percentage cover of the tree, shrub and herbaceous layers was estimated using the Braun-Blanquet cover abundance scale. (Mueller Dombois & Ellenberg, 1974) (Table 3.1) Total woody species density as well as the density of each woody species was measured at each sample plot. Trees were considered as rooted, woody, self-supported plant species taller than 2 meters with one or a few definite trunks, and shrubs as rooted, woody plants up to 2 meters tall, multi-stemmed and branching from the ground. (Edwards, 1983)

Environmental data recorded included geology, soil texture, degree of erosion, a measurement of aspect using a compass, and slope with the aid of a clinometer. The fieldwork was done between December 2001 and April 2002.

Taxon names conform to those of Arnold & De Wet. (1993) No attempt was made to formally fix syntaxa names formally as this is normally avoided in detailed local studies. (Coetzee, 1983)

Table 3.1: Braun-Blanquet cover abundance scale used in this study (Mueller Dombois & Ellenberg, 1974)

SCALE	DESCRIPTION
R	One or few individuals with less than 1% cover of the total sample plot area
+	Occasional and less than 1% cover of the total sample plot area
1	Abundant with low cover, or less abundant but with higher cover, 1-5% cover of the total sample plot area
2 2a 2b	Abundant with >5-25% cover of the total sample plot area, irrespective of the number of individuals >5-12.5% cover >12.5-25% cover
3	>25-50% cover of the total sample plot area, irrespective of the number of individuals
4	>50-75% cover of the total sample plot area, irrespective of the number of individuals
5	>75% cover of the total sample plot area, irrespective of the number of individuals

Data processing

The floristic data were analysed according to Braun-Blanquet procedures using TURBOVEG. (Hennekens, 1996a) The floristic data were analysed using a multivariate classification program TWINSPAN (Two-way Indicator Species Analysis) (Hill, 1979) to obtain a first approximation of the main plant communities by statistical methods and to detect floristic relationships between plant communities. This numerical classification program is regarded as a successful approach for vegetation classification by various phytosociologists. (Bredenkamp & Bezuidenhout, 1995; Cilliers, 1998)

Further refinement of the vegetation classification was achieved by applying Braun-Blanquet procedures. (Bredenkamp *et al.,* 1989; Kooij, *et al.,* 1990; Bezuidenhout, 1993; Eckhart, 1993; Brown & Bredenkamp, 1994)

The visual editor MEGATAB by (Hennekens, 1996b) was used to generate a phytosociological table. Using the phytosociological table and the habitat information collected during the sampling in the field, the various plant communities were identified, described and ecologically interpreted.

BABOON ECOLOGY

Sampling

The study was conducted on a baboon troop at the Bourke's Luck section of the BCNR over a one-year period between March 2001-March 2002. The study troop was referred to as the Bourke's Luck Canyon Troop (BLCT). The study troop was chosen because it was of average size, was not provisioned by humans, and had a home range that was judged to fall wholly within the nature reserve.

The study troop was habituated over a period of three months prior to the study period in order to get close enough to the troop to obtain good quality data (approximately 30m). The aim was to locate the troop at first light, by using binoculars, at their sleeping site and to follow them on foot until they moved onto a sleeping cliff in the evening. The study troop was followed for an average of two full days per month during the study period. This represented a fraction of the attempts that were made to collect data, as follows could be truncated or terminated either by bad weather or by an inability to track the troop through extremely broken terrain.

Activity data

Data on activity states were collected by scan sampling at fifteen-minute intervals and the data was logged on a data logger. Four exclusive states were identified: moving, resting, socialising, foraging (Table 3.2). These scans were used both to determine the relative allocation of time by the troop to various activities and the relative contribution of various plant species and parts to the diet.

Table 3.2: Activity data was collected on the study troop, at 15-minute intervals, making use of four main categories.

Activity	Definition
Walking	When the baboon moved more than one baboon length on the ground.
Resting	When the baboon was stationary, not taking part in any activity.
Socialising	Included all social activities (mating, grooming, fighting etc.).
Foraging	When the baboons were observed foraging plants, the species and the food part eaten were noted. Plant species were identified while the baboons were foraging using local knowledge or the plant was collected and identified by botanists. The food parts eaten were categorised (Table 3.3).

Foraging data

For each recorded food species, the part(s) eaten were noted (Table 3.3). Data were collected for each individual in four different age-sex classes namely, adult, subadult, juvenile and infants. This was to determine if there were different foraging strategies within these age and sex classes (Table 3.4).

Age and sex classification

Classification of the sex and age of each individual of the troop was done according to the classes listed in Table 3.4.

Table 3.3: Food parts selected and eaten from various plant species by the study troop

Food part	Description
Roots	Monocotyledon and dicotyledon roots
Leaves	Monocotyledon and dicotyledon leaves
Seeds	Monocotyledon and dicotyledon seeds
Fruit	Fruit from trees, vines, shrubs and forbs at any stage of maturity
Pods	Dicotyledon pods identified e.g. *Acacia siberiana*
Bark	Bark of trees and shrubs
Flowers	Dicotyledon flowers
Insects	Insects caught and eaten
Other	All other possible food items not listed above

Table 3.4: Classification of the sex and age classes of the study troop (Stoltz, 1969)

Sex & age	Description
Infant	Classified as a very small baby baboon dark in colour, 1-15 months old, until weaned and can forage by it self
Juvenile female	Classified as female baboon 15 months to 3 years old
Juvenile male	Classified as a male baboon 15 months to 5 years old
Subadult male	Classified as a male baboon 5 to 7 years old
Adult male	Troop leader

Data analysis

Data were downloaded from the data logger into a commercial spreadsheet package and exported to SPSS for analysis. The Shapiro-Wilk test (Kinnear & Gray, 1997) was used to determine the normality of the data to determine whether there were significant deviations from the normal distribution.

A one-way (ANOVA) test was used to determine if there was a difference between the mean troop sizes from differing primary habitat types

The Spearman rank-order correlation analysis was used to detect correlation between day journey length and day journey area. To test for seasonal effects in the degree to which food species were sought out, the cumulative seasonal distributions of electivity indices were compared using the Kolmogarov-Smirnov two-sample test (Kinnear & Gray1997)
The distances travelled during the dry and wet seasons were compared with t-tests. All tests were two-tailed with P set at 0.05.

Activity budget

The activity budgets for each sample period were calculated as follows:

$$\frac{\sum(records\_for\_activity\_i)}{\sum(records\_for\_activities)} \times\_100$$

The activities qualified were: *i* = foraging, walking, resting and socialising. The activity records for the adults were grouped together to get an overall time budget.

Ranging data

During whole-day follows, a GPS reading was taken whenever the troop changed its position. The data was logged on a data logger and transferred to a computer where these positions were placed as points on a 1:20 000 digitised aerial map. These points were used to calculate both the distance that the troop covered during the day (the day range distance) as well as the area it utilised (as a minimum convex polygon connecting the points) This information was combined to estimate the annual home range.

Troop densities and demography of the BCNR

During the study period, most of the accessible areas on the escarpment section of the BCNR were visited bi-monthly in order to locate all the other baboon troops in these remote areas. The areas were covered on foot and all the baboon troops were counted, and the basic troop structure identified. The location of all troops was mapped on a 1:50 000 topographical map in order to be able to calculate home range sizes. These polygons were digitised as minimum areas and the areas calculated using Arcview. These baboon troops were named after the geographical area they occupied.

Electivity index

The Krebs' (1989) electivity index was used to determine the species preference for the study troop. Electivity indices are a variant of the more familiar selection ratios, with the advantage that it only varies between -1 (not selected) and +1 (highly selected) and not between zero and infinity. This makes the comparison between species easier and was calculated as follows:

$$EI = \frac{(r_i - n_i)}{(r_i + n_i)}$$

where r_i is the percentage of species *i* in the diet and n_i is the relative available of species *i.* in the habitat. The preferred communities or species are reflected above the x-axis on the graphs and the non-preferred species are reflected below the x-axis.

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CHAPTER 4

A VEGETATION DESCRIPTION OF THE BOURKE'S LUCK SECTION OF THE BLYDE CANYON NATURE RESERVE, MPUMALANGA

INTRODUCTION

The Mpumalanga Province has an extraordinary diversity of plant species with an estimated 4 946 plant taxa occurring within the province. (Lotter *et al*., 2002) The importance of the escarpment area is emphasised by the fact that it has been identified as an important centre for endemism. (Fourie *et al.,* 1988; Matthews *et al.,* 1993) The BCNR in particular was identified as an important conservation area in this respect. (Bredenkamp *et al*., 1996)

Nature reserves provide reservoirs of a country's fauna and flora. (Greyling & Huntley 1984) It is therefore important to investigate their natural resources, in order to compile scientifically sound management programmes and conservation policies. (Brown *et al.,* 1996; Brown, 1997) Because ecosystems react differently to various management practices (Bredenkamp, 1982; Bezuidenhout, 1993), it is important that a description and classification of the vegetation of an area is done. (Van Rooyen *et al.,* 1981) It is widely recognised that a detailed description, identification, classification and mapping of the vegetation forms the basis for sound land-use planning and management. (Tueller, 1988; Fulls *et al*., 1992; Fulls, 1993; Bezuidenhout, 1996; Brown *et al*., 1997) Ecological inventories of the vegetation in conservation areas as the habitat for plants and animals therefore have a central position in nature conservation. (Brown *et al.,* 1996) (Bredenkamp & Brown, 2001)

Plant communities represent ecosystems and form the basis of any management plan for natural areas. If these ecosystems and their different potentials are not known, they cannot be managed successfully. (Brown & Brand 2004) Various animal species occupy and utilise various plant communities for various activities such as sleeping, feeding and reproducing. The study of the vegetation (plant communities) of the home range of an animal must therefore form the basis on which the ecology, social interaction and dietary requirements of any animal is based. (Brown, 2003)

Baboons are highly intelligent and ecologically flexible animals and exploit diverse habitats. They forage on a wide variety of plant species, insects, reptiles and often mammals. Although baboons are mainly vegetarian, the main facet of their diet is the ability to adapt to any environment and to utilise whatever food is available (De Vore & Hall, 1965) Part of this flexibility has the consequence that they can and do exploit human habitats, often causing damage to crops and forest plantations as well as to human dwellings. This has led to baboons being regarded as problem animals that should be eradicated from these areas.

Currently there are no formal management plans for baboons by most nature conservation authorities and reserves. Thus as a first step to implementing a conservation policy to manage such animals in the BCNR, it is necessary to have some understanding of their exploitation of natural habitats in areas where they do cause problems. No policies regarding nature conservation can be drawn up if it is not known what is to be conserved, why it has to be conserved or what the present status is. (Anon, 1985)

The BCNR is a large, protected area surrounded by both subsistence and commercial agricultural ventures of which plantings of commercial pine trees predominate. Baboons are known to cause damage to young pine trees at a commercially significant rate (Bigalke & van Hensbergen, 1990), although this damage is not severe at the BCNR. Since it is possible that utilisation of pine plantations is driven by the local destruction of natural habitat, it is important to determine the extent to, and conditions under which baboons damage pine trees where they have available to them the full range of natural vegetation.

Thus as part of a study to determine and quantify the habitat use of baboons it was essential to undertake a detailed vegetation study of the home range of a single baboon troop within the Bourke’s Luck section of the BCNR. Since 1985 various vegetation studies were conducted on the broader vegetation types of the north eastern mountain region of Mpumalanga. (Deall, 1985, *et al.,*1989a, *et al.,*1989b; Matthews *et al*., 1991) Although a broad vegetation map of the BCNR exists, no detailed vegetation studies have been conducted on the largest part of the reserve. The main aim of this study was therefore to describe and map the plant communities of the Bourke's Luck section of the reserve.

RESULTS

Classification

Approximately two thirds of the study area comprises grassland vegetation found predominantly on high and low altitudes while the rest consist of woodland vegetation. The grasses *Loudetia simplex* and *Sporobolus pectinatus* together with the dwarf shrubs *Helichrysum kraussii, Pearsonia sessilifolia* and *Fadogia tetraquetra* (species groups M and N, Table 4.1) are prominent throughout the grassland vegetation and will not necessarily be mentioned repeatedly in the descriptions of the various plant communities.

Owing to the complex and heterogeneous topography and consequent climate differences in the study area a great variation exists in the habitat which has resulted in the recognition of 13 plant communities, which can be grouped into seven major community types. (Fig.4.1) (Table 4.1) The hierarchical classification of the vegetation moreover indicates a strong association between the various plant communities and their respective habitats. (Fig.4.1) The following plant communities were recognised in the study area and are described (all species groups are indicated in Table (4.1) and no specific reference will therefore be made to the table in the description of the various plant communities):

1. *Hyperthelia dissoluta-Heteropogon contortus* Grassland
2 *Diheteropogon amplectens-Loudetia simplex* Grassland
    2.1 *Diheteropogon amplectens-Monocymbium ceresiiforme* Grassland
        2.1.1 *Hemizygia transvaalensis-Themeda triandra G*rassland
        2.1.2 *Diheteropogon amplectens-Pearsonia sessilifolia* Shrubland

2.2 *Helichrysum wilmsii-Panicum natalense* Grassland

2.3 *Diheteropogon amplectens-Brachiaria serrata* Grassland

2.3.1 *Eragrostis gummiflua-Loudetia simplex* Grassland

2.3.2 *Fadogia tetraquetra-Euclea linearis* Shrubland

2.4 *Senecio glaberrimus-Pearsonia sessilifolia* Shrubland

3. *Englerophytum magalismontanum-Helichrysum kraussii* Shrubland

4. *Pterocarpus angolensis-Englerophytum magalismontanum* Woodland

5. *Faurea saligna- Cymbopogon vallidus* Woodland

6. *Combretum kraussii- Acacia ataxacantha* Woodland

6.1 *Englerophytum magalismontanum- Acacia ataxacantha* Woodland

6.2 *Combretum kraussii- Acacia ataxacantha* Woodland

7. *Pinus patula* Woodland

Description of the plant communities

1 *Hyperthelia dissoluta-Heteropogon contortus* Grassland

The *Heteropogon contortus-Hyperthelia* Grassland is situated in the southern section of the study area and is elevated above the Treur River. (Fig.4.1) The terrain is relatively flat with an eastern slope of 5-6º and an altitude of 1180 m above sea level. No visible rocks are present and although the soil is deeper than that of other communities in the study area, it is still fairly shallow. (MB1 many stones but ploughable.) (Land Survey Staff, 1989)

The diagnostic species include the grasses *Heteropogon contortus*, *Hyperthelia dissoluta* together with the forbs *Verbena brasiliensis* and *Helichrysum callicomum.* *(*species group A, Table 4.1)

There is no tree or shrub layer present and the vegetation is characterised by the presence of an herbaceous layer only. The grass layer has an 80% coverage, while the forb layer covers 10% of the area. The grasses *Heteropogon contortus* (species group A) and *Hyperthelia dissoluta* (species group A) dominate this community, while *Hyparrhenia filipendula* (species group D) and *Diheteropogon amplectens* (species group B) are also prominent within this community. The grass *Themeda* *triandra* (species group C) is prominent locally. Prominent forbs include *Helichrysum nudifolium, Senecio junodii* (species group D) and *Crotalaria doidgeae* (species group M)

This community comprises 14.3 ha which is 2.7% of the total study. An average of 13 species per 200 m^2 was recorded in this plant community. This community is on average burnt every year which explains the low species richness, as well as the presence of the grasses *Heteropogon contortus* (species group A), *Hyperthelia dissoluta* (species group A), *Hyparrhenia filipendula* (species group D), *Diheteropogon amplectens* (species group B) and *Themeda triandra* (species group C) all of which are fire climax grasses that are stimulated by a regular fire regime.

The disturbed nature of this community is also reflected in the presence of the pioneer grass *Melinis repens* (species group V) and the pioneer forb *Verbena brasiliensis* (species group A).

2. *Diheteropogon amplectens-Loudetia simplex* Grassland

This grassland community is found throughout the study area on high-lying areas and mid slopes. The terrain is generally flat with gentle slopes. Altitude varies between 1140-1280 m above sea level. The area has distinctive flat rocky sections with rockiness varying between 5-70%. Soil depth varies from shallow to very shallow. (MB3 very shallow soils on rock.) (Land Survey Staff, 1989)

Species diagnostic for this community are the grasses *Diheteropogon amplectens, Aristida junciformis,* the dwarf shrub *Lannea edulis*, the forbs *Hemizygia transvaalensis, Phymaspermum acerosum, Senecio scitus* and *Bulbostylis burchellii, Vernonia natalensis* (species group B).

The woody layer is absent and this community comprises a grass layer with a 15-70% cover. The vegetation is dominated by the grasses *Loudetia simplex* (species group M) *Diheteropogon amplectens* (species group B) and *Sporobolus pectinatus* (species group M) The forbs *Bulbostylis burchellii, Hemizigya transvaalensis* (species group B), *Helichrysum kraussii* and *Crotalaria doidgeae* (species group M).

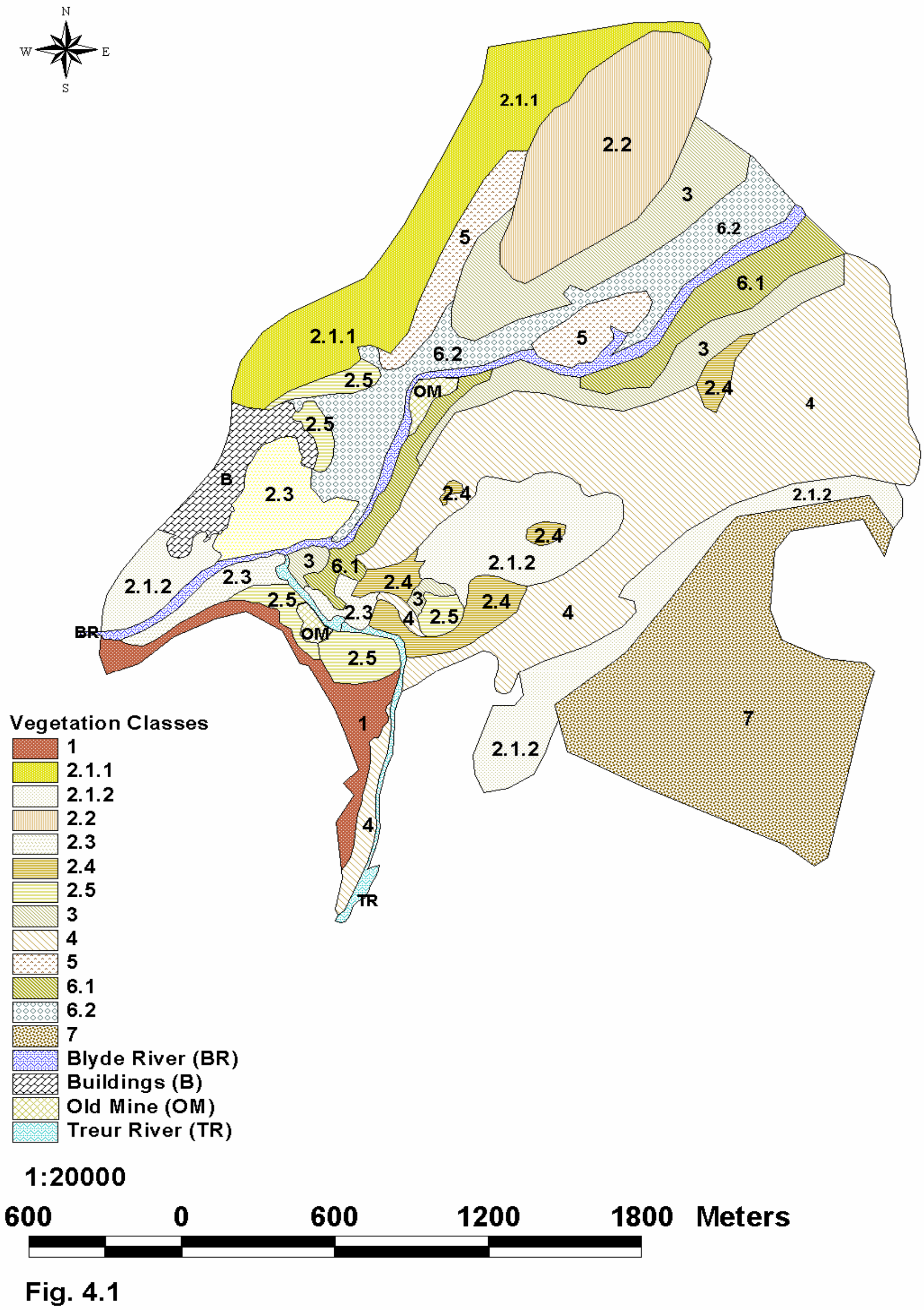

Figure 4.1: Distribution of the various vegetation types on the Bourke's Luck section of the BCNR.

are also prominent. The endemic forb *Hemizygia parvifolia* (species group O) is locally present in this community.

This major community shows affinity to the *Hemizygio-Loudetia simplex a*ssociation as described by Matthews *et al*., (1991) and the *Diheteropogon plectentis-Proteetum gaguedi* subassociation as described by Matthews *et al.*. (1994) Sections (subcommunities 2.1, 2.2) of the *Diheteropogon amplectens-Loudetia simplex* grassland are characteristic of the drier and higher altitude communities as described by Matthews *et al*., (1991) and Matthews *et al.* (1994).

This community is divided into four subcommunities, two with two variants.

2.1. *Diheteropogon amplectens-Monocymbium ceresiiforme* Grassland

The *Diheteropogon amplectens-Monocymbium ceresiiforme* Grassland consists of high altitude grassland ranging between 1140-1280 m above sea level. The area is generally flat with a slope of 2-6º southwest with shallow soils (MB3 very shallow soils on rock.) (Land Survey Staff, 1989) Rocky cover varies between 5-60%.

This sub–community is characterised by the species belonging to species group E and includes the grasses *Monocymbium ceresiiforme, Eragrostis capensis* and the forbs *Athrixia phyllicoides, Triumfetta welwitchia, Helichrysum cooperi and Lotononis eriantha.*

The tree layer has a 0-5% cover, the grass layer 15-50% cover, and the forb layer a 30-55% cover. The grasses *Diheteropogon amplectens* (species group B) and *Monocymbium ceresiiforme* (species group E) together with the aromatic forb *Hemizygia transvaalensis* (species group B) dominate this community, while the grasses *Loudetia simplex* and *Sporobolus pectinatus* (species group M) are locally prominent. The grasses *Aristida junciformis* (species group B) and *Eragrostis racemosa* (species group H) are also characteristic of this subcommunity. Prominent forbs include *Acalypha villicaulis* (species group M), *Bulbostylis burchellii* and *Phymaspermum acerosum* (species group B).

This subcommunity covers and area of 119.3 ha which is 22.8% of the total study area. Owing to accidental burns the fire frequency varies between 1-2 years. An average number of 35 species per 200 m^2 were recorded within this community.

The prominence and presence of the grasses *Aristida junciformis* (species group B), *Themda triandra, Bewsia biflora* (species group C), *Monocymbium ceresiiforme* (species group E), *Panicum natalense* (species group F), *Eragrostis racemosa* (species group H), *Loudetia simplex* (species group M) and the forb *Bulbostylis burchellii* (species group B) within this subcommunity shows a remarkable similarity to the *Monocymbium ceresiiforme-Loudetia simplex* grassland found on the Bankenveld (Bredenkamp & Brown, 2003) The presence of the species *Monocymbium ceresiiforme* (species group E), *Loudetia simplex* (species group M), *Panicum natalense, Themeda triandra* (species group C) and *Cyanotis speciosa* (species group O) also indicates an affinity to the Drakensberg vegetation.

This sub community can be divided into two variants:

2.1.1. *Hemizygia transvaalensis–Themeda triandra* Grassland

This variant is predominantly found in grasslands with a gentle (6º) southwestern slope and is situated in the northwestern border of the study area (Figure 5). Altitude varies between 1160-1200 m above sea level. The soil is shallow and shows signs of early disturbance from mining and old road works. The rockiness is estimated to be 5%. (MB1 many stones but ploughable.) (Land Survey Staff, 1989)

The following species belonging to species group C, are diagnostic for this variant: *Setaria ustilata, Bewsia biflora, Eragrostis curvula, Themeda triandra* and the forbs *Agathisanthemum bojeri, Nidorella auriculata, Crassula lanceolata, Helichrysum oxyphyllum* and *Tephrosia lupinifolia*.

The woody layer consists of the dwarf shrub *Lannea edulis* (species group B) that occurs scattered in small clumps throughout the area covering an estimated 1-5% of the area. The herbaceous layer is the most prominent with the grasses covering an estimated 45% of the area and the forb layer covering between 25-55% of the area.

The vegetation is dominated by the grasses *Themeda triandra* (species group C), *Diheteropogon amplectens* (species group B), *Monocymbium ceresiiforme* (species group E) and the aromatic forb *Hemizygia transvaalensis* (species group B) Other grasses that are also present include *Aristida junciformis* (species group B) and *Sporobolus pectinatus* (species group M) Prominent forbs include *Commelina africana* (species group M) and *Helichrysum cooperi* (species group E) while *Helichrysum nudifolium* (species group D), *Pearsonia sessilifolia filifolia* (species group G) and *Crotalaria doidgeae* (species group M) are also present in this variant.

2.1.2. *Diheteropogon amplectens–Pearsonia sessilifolia* Shrubland

This variant also occurring in higher lying grassland in the central and eastern section of the study area (Fig.4.1) with gentle slopes ranging between 2-6º south. Altitude ranges between 1140-1280 m above sea level. The soil is shallow while rockiness varies between 30-60%. (MB3 very shallow soils on rock.) (Land Survey Staff, 1989)

This variant is characterised by the absence of species belonging to species group D.

The woody layer comprises scattered trees and shrubs with a 0-5% and 5-15% coverage respectively. The grass layer has a 15-50% cover and the forbs 30-50% coverage.

The vegetation is dominated by grass *Diheteropogon amplectens* (species group B) and the distinctive silvery forb *Pearsonia sessilifolia sessilifolia* (species group N) The grass *Loudetia simplex* (species group M) and the aromatic forb *Hemizygia transvaalensis* (species group B) are very prominent as well. Other species present include the dwarf shrub *Lannea edulis* (species group B), the grasses *Eragrostis racemosa* (species group H), *Elionurus muticus* (species group I), *Brachiaria serrata* (species group G) and *Sporobolus pectinatus* (species group M), and the forbs *Phymaspermum acerosum* (species group B), *Zornia linearis* (species group I) and *Crotalaria doidgeae* (species group M).

2.2. *Helichrysum wilmsii–Panicum natalense* Grassland

This subcommunity occurs on the higher, more flat grassland area in the northern section of the study area (Fig.4.1). The altitude varies between 1260-1280 m above sea level, with a 5º southwestern slope. The soil is shallow with a low rock cover ranging between 5-15%. (MB1 many stones but ploughable.) (Land Survey Staff, 1989)

There are no trees present and dwarf shrubs with an estimated 5% cover represent the woody layer. The grasses with 35-70% cover and the forbs with 30-50% cover are the most prominent vegetation layers.

Diagnostic species of this subcommunity include: *Panicum natalense, Helichrysum wilmsii, Senecio macroglossus, Oxalis obliquifolia, Athrixia alata, Cyperus obtusifloris (*species group F).

Dominant species of this subcommunity include the grasses *Panicum natalense* (species group F), *Loudetia simplex* (species group M) and the shrub *Helichrysum wilmsii* (species group F) Prominent species are the forbs *Aeschynomene rehmannii* (species group N)*, Helichrysum kraussii* (species group M) and *Hemizygia transvaalensis* (species group B) The forbs *Helichrysum cooperi* (species group E)*, Commelina africana* (species group M)*, Phymaspermum acerosum* (species group B) and the grass *Themeda triandra* (species group C) are also present in this sub community.

With a size of 47.8 ha, this community represents 9% of the total study area. The average number of species recorded within this plant community per 200 m^2 is 27. This area had fire 4 years ago and the average fire frequency is 2-4 years.

2.3 *Diheteropogon amplectens-Brachiaria serrata* Grassland

This subcommunity occurs along the lower and flatter grassland areas of the reserve between 1140-1220 m above sea level. Rock cover varies between 5-70% with shallow soil present. (MB3 very shallow soils on rock.) (Land Survey Staff, 1989)

A few Rhus pyroides shrubs represent the woody layer and the dwarf shrubs *Fadogia tetraquetra* and *Pearsonia sessilifolia* (species group N) with a 1-25% cover. The grass layer covers between 15-70% of the area while the forb layer has a 15-65% cover. The dwarf shrub *Fadogia tetraquetra* (species group N) and the grasses *Loudetia simplex* and *Sporobolus pectinatus* (species group M) totally dominate the vegetation in this area. Prominent species include the dwarf shrubs *Helichrysum kraussii* (species group M), *Aeschynomene rehmannii* (species group N), the grasses *Diheteropogon amplectens* (species group A), *Brachiaria serrata* (species group G), the forbs *Senecio glaberrimus, Rhynchosia monophylla, Pachystigma latifolium* (species group N) and the geophyte *Hypoxis rigidula* (species group N) The moss *Selaginella dregei* (species group O), the forb *Kyllinga alba* and the geophyte *Hypoxis iridifolia* (species group G) are locally prominent.

With a total size of 43 ha (8.1% of the total study area) this subcommunity has the highest average number of species per 200 m^2 namely 38. This area is burned every three to four years.

This subcommunity has two variants:

2.3.1. *Eragrostis gummiflua-Loudetia simplex* Grassland

This variant occurs along the western section of the study area on lower grassland sections (Fig.4.1). The altitude varies between 1140-1180 m above sea level, with a predominantly western slope between 2-8º. The soil is very shallow with a 5-70% rocky cover. (MB3 very shallow soils on rock.) (Land Survey Staff, 1989)

The tree layer is absent and only shrubs with an estimated 5-10% cover are present. The grass layer is dominant and covers between 40-60% of the area while the forbs have an estimated cover of 15-40%.

Diagnostic species of this sub–community include the shrub *Diospyros lycioides*, the grasses *Eragrostis gummiflua, Eragrostis racemosa, Digitaria monodactyla, Melinis nerviglumis* and the forbs *Wahlenbergia undulata, Commelina benghalensis, Trachyandra saltii, Ipomoea bathycolpos, Gladiolus crassifolius, Pearsonia sessilifolia filifolia* (species group H).

Dominant species of this sub community are the grasses *Sporobolus pectinatus* and *Loudetia simplex* (species group M). Prominent species of this sub community includes the dwarf shrub *Fadogia tetraquetra* (species group N), the grass *Brachiaria serrata* (species group G) and the forb *Bulbostylis burchellii* (species group B). The dwarf shrub *Parinari capensis* (species group N) and the grasses *Heteropogon contortus* (species group A), *Aristida junciformis* (species group B), *Cymbopogon validus* (species group Q) and the forbs *Pearsonia sessilifolia* and *Cheilanthes eckloniana* (species group N) are also present in this variant.

2.3.2. Fadogia tetraquetra-Euclea linearis Shrubland

The *Fadogia tetraquetra-Euclea linearis* Shrubland occurs scattered throughout the study area on the lower flatter grassland areas (Fig.4.1). Altitude ranges between 1 140-1 220 m above sea level, with a predominantly southern slope of 1-6º. The shallow soil has a 35-70% rock cover. (MB3 very shallow soils on rock.) (Land Survey Staff, 1989)

Tree and shrub cover varies between 1-20%, grass cover between 15-60% and the forb cover between 10-40%.

The dwarf shrub *Myrothamnus flabellifolia,* the grasses *Brachiaria serrata, Elionurus muticus, Microchloa caffra* and the forbs *Gnidia splendens and Zornia linearis,* (species group I) are diagnostic for this variant.

The dwarf shrubs *Euclea linearis* (species group P) and *Fadogia tetraquetra* (species group N) dominate the vegetation, while the dwarf shrubs *Pearsonia sessilifolia* (species group N) and the grasses *Loudetia simplex* and *Sporobolus pectinatus* (species group M) are very prominent as well. Other conspicuous species include the tree specie *Faurea saligna* (species group P) and the forb *Aeschynomene rehmannii* (species group N) Also present in this variant are, dwarf shrub *Indigofera melanadenia* (species group P), the grass species *Setaria pallide-fusca* (species group O), *Diheteropogon amplectens* (species group B) and the forbs *Lopholaena coriifolia* (species group P) and *Rhynchosia monophylla* (species group O).

2.4. *Senecio glaberrimus-Pearsonia sessilifolia* Shrubland

This subcommunity occurs in the lower grassland areas along the southern section of the study area (Fig.4.1). The altitude is 1 140-1 180 m above sea level, with a 2-8º north-western slope. The soil is very shallow with a 10-80% rock cover. (MB3 very shallow soils on rock.) (Land Survey Staff, 1989)

The tree and shrub cover varies between 1-10% and 5-10% respectively, while the grass and forb cover varies between 15-60% and 10-35% respectively.

Species from species group J are diagnostic for this subcommunity and include the tree *Ximenia caffra,* the dwarf shrub *Elephantorrhiza elephantina* and the forbs *Aloe dewetii* and *Crassula capitella*.

The vegetation of this subcommunity is dominated by the forbs *Senecio glaberrimus* (species group O) and *Pearsonia sessilifolia* (species group N) Prominent species include the tree *Englerophytum magalismontanum* (species group P), the grass specie *Hyperthelia dissoluta* (species group A) and the forbs *Phymaspermum acerosum* (species group B), *Cheilanthus eckloniana* (species group N) Other species also present in this subcommunity include the tree *Vangueria infausta* (species group P) the grass *Danthoniopsis pruinosa* (species group L), the forbs *Aeschynomene rehmannii* (species group N), *Rhynchosia* monophylla (species group O), *Rhynchosia nitens* (species group Q), *Lopholaena coriifolia*, *Cryptolepis oblongifolia* (species group P).

This subcommunity comprises approximately 15 ha (2.9% of the total study area) and is exposed to fire every 2-3 years. An average of 34 species per 200 m^2 has been recorded within this subcommunity.

3. *Englerophytum magalismontanum–Helichrysum kraussii* Shrubland

Situated in the northern and central sections of the study area (Figure 5) this community occurs on dry steep and high lying areas with altitudes ranging between 1140-1260 m above sea level. The gentle to steep slopes vary between 3-19º, while 25-70% of the shallow soil is covered with rocks. (MB2 large stones and boulders unploughable.) (Land Survey Staff, 1989)

The woody layer is most prominent with the trees and shrubs covering between 1-15 and 2-20% respectively. The grass layer is not well-developed and has a cover of only 20% while the forb layer covers up to 60% of the area in some places.

The diagnostic species for this community are: *Tetraselago wilmsii, Pellaea calomelanos, Helichrysum uninervium, Smilax anceps, Pteridium aquilinum*, and *Kotschya parvifolia* (species group K).

The woody layer is dominated by the tree *Englerophytum magalismontanum* (species group P), while the grass and forb layers are dominated by *Loudetia simplex* and *Helichrysum kraussii* (species group M) respectively. Prominent species in this community include the shrub *Rhus pyroides* (species group N) and the dwarf shrub *Fadogia tetraquetra* (species group N) Other species conspicuous locally are the tree *Syzygium cordatum* (species group L), *Faurea saligna* (species group P) and the dwarf shrub *Euclea linearis* (species group P) The grass, *Cymbopogon vallidus* (species group Q) and the forbs *Indigofera melanadenia* (species group P), *Senecio glaberrimus, Hypoxis rigidula* (species group O) are also present. The endemic small shrub *Euclea dewinteri* (species group Q) has also been recorded at one locality within this community.

This is one of the larger communities in the study area and comprises close to 65 ha that is 12.4% of the total study area. The average number of species per 200 m^2 that has been recorded for this community is 33.

Matthews *et al.* (1991) described a similar community on the rocky outcrops of the northeastern sourveld. The species composition of this community and the one described by Matthews *et al.* (1991) shows affinity to the Bankenveld vegetation. (Bredenkamp & Theron 1978; Bredenkamp & Brown 2003)

4. *Pterocarpus angolensis-Englerophytum magalismontanum* Woodland

This community occurs on the highest lying areas of the study area (Fig. 4.1). Altitude varies 1140-1300 m above sea level, with gentle to steep southwestern slopes ranging between 0-18º. The soil is very shallow with a rockiness of 30-80%. (MB3 very shallow soils on rock.) (Land Survey Staff, 1989)

The tree layer has a 5-65% and the shrub layer 5-50% coverage compared to the 5-50% and 5-40% coverage of the grass and forb layers respectively.

Diagnostic species of this community include the trees, *Syzygium legatii, Pterocarpus angolensis, Syzygium cordatum, Ekebergia pterophylla, Brachylaena transvaalensis, Combretum molle, Pterocelastrus echinatus, Parinari curatellifolia, Strychnos spinosa, Cussonia natalensis, Heteropyxis natalensis,* the shrubs *Ochna confusa*, *Pavetta schumanniana,* the grass *Danthoniopsis pruinosa and the forbs Cyperus esculentus, Anisopappus smutsii, Asparagus virgatus, Aeollanthus parvifolius, Rhoicissus tridentata, Tetradenia riparia and Helichrysum odorattissimum* (species group L).

The vegetation is dominated by the trees *Pterocarpus angolensis* (species group L), *Englerophytum magalismontanum* and the shrub *Euclea linearis* (species group P) The grasses *Loudetia simplex* (species group M) and *Tristachya leucothrix* (species group P) and the forbs *Helichrysum kraussii* (species group M), *Fadogia tetraquetra* (species group N) and *Cryptolepis oblongifolia* (species group P) are also prominent. Other conspicuous species include the trees *Vangueria infausta, Faurea saligna* (species group P) and the shrub like *Rhus pyroides* (species group N) The grass *Sporobolus pectinatus* (species group M) and the forbs *Smilax anceps* (species group K), *Crotalaria doidgeae* (species group M), *Aeschynomene rehmania leptobotra*, *Cheilanthus eckloniana* (species group N), *Indigofera melanadenia* (species group P) are also present within this community.

As the largest community within the study area (137 ha) this community comprises 26% of the total study area and the second highest average number of species (36) per 200 m^2. Owing to the shallow soils and species composition, this community has a low production resulting in it being susceptible to fire every 4-5 years.

5. *Faurea saligna–Cymbopogon vallidus* Woodland

Situated in the northern and central sections of the study area (Fig.4.1), this open woodland occurs on steep high lying areas with lower altitudes varying between 1160-1200 m above sea level. The moderate to steep southeastern slopes vary between 5-29º. The shallow soil has a low rock cover ranging between 10 and 40%. (MB2 large stones and boulders unploughable.) (Land Survey Staff, 1989)

The tree layer is the most prominent and has an estimated 60% cover while the shrub layer has a 20% coverage. The herbaceous layer has a 10-40% grass cover and a 10-20 % forb cover.

Diagnostic species of this community include *the trees Tricalysia lanceolata, Rhus dentata*, *Rhus transvaalensis,* the endemic dwarf shrub *Euclea dewinteri, the grass Cymbopogon validus and the forbs Rhynchosia nitens and Polygala hottentotta* (species group Q).

The tree *Faurea saligna* (species group P) and the grass *Cymbopogon validus* (species group Q) dominate the vegetation while prominent species include the dwarf shrubs *Fadogia tetraquetra, Pearsonia sessilifolia* (species group N) and the forb *Tetraselago wilmsii* (species group K).

This community comprises 19 ha which is 3.6% of the total study area. An average of 28 species was recorded in 200 m^2 and has not been exposed to fire for the past 14 years.

6. *Combretum krausii–Acacia ataxacantha* Woodland

This dense indigenous riverine forest occurs along the lower-lying more moist areas on steep slopes and valley bottoms of the Blyde River Canyon (Figure 5). The vegetation is protected against fire and wind resulting in a well-developed woody layer. The altitude varies between 1 060-1 100 m above sea level, with moderate to steep east and west-facing slopes ranging between 8-30º. The soil varies between shallow and dry to deep and moist while rock cover is high between 70-80 º.
The vegetation is dominated by the woody layer with 70-100% coverage, while the herbaceous layer is generally not well developed and has a low cover estimated at between 5-40%.

This community is characterised by the presence of the following diagnostic species: *Acacia ataxacantha, Diospyros whyteana, Combretum kraussii, Rhamnus prinoides, Maytenus undata, Maytenus mossambicensis, Ficus ingens, Tarchonanthus camphoratus, Ziziphus mucronata, Dalbergia armata, Erythroxylum delagoense, Bowkeria cymosa, Ochna holstii, Euclea crispa* (species group R).

The vegetation is dominated by the trees *Acacia ataxacantha* and *Combretum kraussii* (species group R) while the tree *Englerophytum magalismontanum* (species group P) is also prominent.

The presence of the woody species *Rhamnus prinoides, Ziziphus mucronata, Grewia occidentalis* and *Clematis brachiata* indicates an affinity with bushveld vegetation Matthews (1991). This community also shows an affinity with the *Acacio ataxacanthae-Celticum africanae* association described by Matthews (1991) which is characteristic for valley bottoms as well as protected areas on valley sides.

This community is divided into two sub–communities:

6.1. *Englerophytum magalismontanum–Acacia ataxacantha* Woodland

This subcommunity occurs along the steep (26º-30º) western slopes on the edge of the Blyde River Canyon (Fig.4.1). Altitude varies between 1100-1160 m above sea level and the shallow soils are mostly covered with large boulders covering approximately 80% of the area. (MB2 large stones and boulders unploughable.) (Land Survey Staff, 1989)

The vegetation consists mainly of trees taller than 2 metres that cover between 70-100% of the area. The shrub layer has a 10-20% cover while the grass layer is not well developed and covers only 5%. Diagnostic species of this subcommunity are the trees *Canthium mundianum, Peltophorum africanum* and *Olinia emarginata* (species group S).

The woody layer is dominated by the trees *Englerophytum magalismontanum* (species group P) and *Acacia ataxacantha* (species group R). Prominent species includes the trees *Ziziphus mucronata, Ficus ingens, Combretum kraussii* (species group R) and *Heteropyxis natalensis* (species group L).

Sections of this small community (9 ha) were disturbed by mining activities 35 years ago. A Total of 23 species per 200 m^2 has been recorded for this community, which is only burned every 7-10 years.

6.2. *Combretum kraussii–Acacia ataxacantha* Woodland

This sub community occurs along the low-lying and more protected areas of the study area within indigenous riverine forests (Fig.4.1). The altitude varies between 1060-1120 m above sea level, while the east-facing slopes are less steep (8-11º) than those of the previous community. The soil is deep and moist and is mostly covered (70%) with huge boulders. (MB2 large stones and boulders unploughable.) (Land Survey Staff, 1989)

The woody vegetation is the most prominent and the trees have an approximate 90% coverage. The shrub layer covers between 1-20% of the area while the herbaceous layer is not well developed with only 5% coverage.

Species belonging to species group T are diagnostic for this subcommunity and include: *Clematis brachiata, Clutia pulchella, Cnestis polyphylla, Ficus thonningii, Halleria lucida, Pittosporum viridiflorum, Rawsonia lucida, Mimusops obovata, Canthium inerme, Rothmannia globosa, Sclerochiton harveyanus, Trema orientalis, Grewia occidentalis.*

The woody vegetation is dominated by the trees *Combretum kraussii, Acacia ataxacantha* and *Ziziphus mucronata* (species group R), while the trees *Rhamnus prinoides* (species group R), *Rhus dentata* (species group Q), *Canthium inerme* and *Halleria lucida* (species group T) are also prominent locally.

This community is 55 ha in size (11% of the total study area) and is only burns every 5-7 years. An average of 31 species recorded per 200 m^2 within this subcommunity.

7. *Pinus patula* Woodland

This community is situated within a pine plantation outside the Bourke's Luck section of the BCNR and was included in this study to ascertain the differences between the vegetation in the plantations and the adjacent natural vegetation with similar topography and geology. The terrain can be described as flat higher lying grassland with no rock cover, shallow soil and a gentle slope of 1-2º south. (MB2 many stones but ploughable.) (Land Survey Staff, 1989) The altitude varies between 1260-280m above sea level. This community comprises of a 15-year old plantation as well as a five-year old plantation.

The commercially planted tree *Pinus patula* (species group U) that is also characteristic for this community dominates the vegetation.

In this 15 year old plantation the tree layer has a 90% cover while the herbaceous layer is extremely degraded and consists of only a few individual grasses and forbs with an estimated 1% cover. In the five-year old plantation the trees cover approximately 40% of the area while the herbaceous layer is not as degraded as the above and covers approximately 50% of the area. Other species present include the forb *Pentanisia angustifolia* and the grass *Sporobolus pectinatus* (species group M). The latter is locally prominent in the younger plantation.

This community is similar in topography to the *Diheteropogon amplectens–Pearsonia sessilifolia* Shrubland (community 2.1.2), but owing to the utilisation of the area for commercial forestry has totally different soil and herbaceous characteristics.

DISCUSSION

Of the various major communities the *Diheteropogon amplectens-Loudetia simplex* Grassland (community 2) shows affinity to the *Hemizygio-Loudetia simplex a*ssociation as described by Matthews *et al*., (1991) and the *Diheteropogon plectentis-Proteetum gaguedi* subassociation (Matthews *et al.*, 1994), while the *Diheteropogon amplectens-Monocymbium ceresiiforme* Grassland (subcommunity 2.1) and the *Helichrysum wilmsii-Panicum natalense* Grassland (subcommunity 2.2) are characteristic of the drier and higher altitude communities described by Matthews *et al*., (1991) and Matthews *et al.,* (1994) The species composition of the *Diheteropogon amplectens-Monocymbium ceresiiforme* Grassland (subcommunity 2.1) also exhibits a remarkable similarity to the *Monocymbium ceresiiforme-Loudetia simplex* grassland found on the Bankenveld (Bredenkamp & Brown 2003) and has Drakensberg affinity.

The *Englerophytum magalismontanum-Helichrysum kraussii* Shrubland (community 3) is similar to that described by Matthews *et al.,* (1991) on the rocky outcrops of the northeastern sourveld while also showing affinity to Bankenveld vegetation. (Bredenkamp & Theron 1978, Bredenkamp & Brown 2003)

The riverine vegetation of the *Combretum kraussii- Acacia ataxacantha* Woodland (community 6) has similarities with bushveld vegetation and shows affinity to the *Acacio ataxacanthae-Celticum africanae* association described by Matthews (1991).

The endemic species *Euclea dewinteri* was also found to be prominent within the *Faurea saligna–Cymbopogon validus* woodland (community 5). According to Schmidt *et al.*(2002) this species is endemic to the Bourke's Luck section of the BCNR.

A total number of 269 different plant species has been identified within the study area. Most communities have a species richness ranging between 25-38 species per 200 m^2. The exception is the *Hyperthelia dissoluta-Heteropogon contortus* Grassland (community 1) with the lowest species richness of 13 species per 200 m^2. The homogeneous nature of this community can most probably be ascribed to the annual burning of this community. This abundance of the fire climax grasses *Diheteropogon amplectens* and *Themeda triandra* together with the grass *Hyperthelia dissolute,* which grows in disturbed places, is an indication of the disturbed nature of this community. Although most of the fires are caused by accidental fires it would be important that measures are taken to ensure that this community is only burned every 3-4 years to ensure establishment of other climax and non-fire resistant species also to ensure biodiversity. All of the other communities have burning cycles longer than 2 years with the longest 14 years. The average burning cycle is every 3-4 years which is recommended for high rainfall areas.

CONCLUSION

By using Braun-Blanquet procedures a total of 13 different and clearly distinguishable plant communities were identified, described and mapped within the Bourke's Luck section of the reserve.

Of the various plant communities identified and described one major community shows affinity to an association and a subassociation previously described by Matthews *et al*. (1991; 1994), while another major community shows affinity to Drakensberg vegetation described by Matthews (1991). The riverine vegetation is found in the lower lying areas that are more protected against wind and cold temperatures and shows affinity to warmer bushveld vegetation.

The endemic species *Euclea dewinteri* found to be prominent within the *Faurea saligna–Cymbopogon validus* woodland (community 5) implies that special management consideration should be given to this woodland to ensure the continued existence of this species within this community.

Fire frequency seems to have an influence on species richness and it would be important that research is undertaken to determine the correct frequency for the various communities within the study area.

This inventory of the ecosystems and biota should form the basis for the compilation of a vegetation-, interpretation- and ecotourism management plan for this section of the reserve. The results of this study will enable management of the BCNR to take scientifically based decisions regarding the management of each of these areas.

This study also forms part of a larger study on the habitat use and range of a single baboon troop. The plant communities identified and described in this study are all situated within the home range of the baboon troop and therefore provides detailed data on the various plant species as well as habitats that exist within their home range. This is essential when determining the amount of time the troop spends in each community / ecosystem within their home range. The data collected in this study will be also be used to develop guidelines for the management of baboon troops in conservation areas.

Without the classification and delineation of the various plant communities, the food availability and use within the various plant communities by the baboon troop could not be determined. When the dietary requirements of these animals and the plant communities within which these food sources occur are known, it would aid management when making decisions on the implementation of a management programme. It is especially important that the dietary requirements of the animals are taken into account when deciding on a burning programme for the area. An incorrect burning programme would not only destroy the habitat, but also cause a reduction in food availability for the baboons. This would result in the animals having to seek food and shelter in adjacent areas including local communities and plantations resulting in them becoming problem animals. The vegetation data discussed in this chapter will also be used in the following chapters to determine plant community preference and use by the baboons throughout the year.

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CHAPTER 5

BABOON ECOLOGY

INTRODUCTION

Chacma baboons are widely distributed in southern Africa and, as a consequence, occupy a broad range of habitats, from subtropical woodland to subalpine grassland (Henzi & Barrett, 2003) Detailed ecological studies from a number of different habitat types exist for the subspecies. They have been studied in subalpine grassland (Whiten *et al*., 1987; Henzi *et al*., 1992) savannah woodland (Stolz & Saayman, 1970; Watson 1985; Gaynor, 1994), in coastal fynbos (Hall, 1962 & 1963; Davidge, 1977 & 1978) as well as under desert conditions. (Hamilton *et al*., 1976; Brain, 1988)

What these studies highlight is that chacma baboons have eclectic diets, and forage on a wide variety of plants, insects, reptiles and, often, mammals. Whiten *et al*. (1987) described the foraging style of baboons as broadly omnivorous with regard to food types, locations and harvesting behaviours. Different habitat types have their own characteristic plant species that may attract baboons at different times of the year. (Henzi *et al.*, 1997) Each of these habitat types often has a mosaic of complex vegetation types and environmental conditions. (See chapter 4.) This means that baboons can occupy broad habitat types while utilising specific vegetation types within their home range differentially throughout the year. In this way, they gain access to a wide range of food and other resources throughout the year. (Henzi *et al*., 1992)

Whiten *et al*. (1987) characterised baboon dietary strategy as ‘eclectic omnivory’, by which they meant that baboon diets, while broad in the sense that a wide array of foods could be used, were also focused. Baboons are highly selective both in their choice of particular food species eaten and in the parts of these species that are eaten. Baboons are able to make use of their hands and mouth to select and discard certain components of the plants and animals that they eat (Whiten *et al*., 1987) Therefore, they are able to feed selectively on the most nutritious parts of the plants available in their habitat at each time of the year. (Altmann & Altmann, 1970; Byrne *et al.*, 1993)

Baboon diets and habitat utilisation will therefore, in summary, reflect local circumstances and differ from area to area in response to the availability of particular plant species.

One consequence of this ecological flexibility is that they are able to exploit artificial human habitats, such as pine plantations and agricultural lands. (Hill, 1997) Where such habitats abut conservation areas that contain baboons, there is a strong likelihood that some fraction of the baboon population will utilise them opportunistically. Where this so, they will, as ‘problem animals’, necessitate the formulation of a locally appropriate conservation policy that deals realistically with stakeholder concerns, while also ensuring the preservation of a viable population. Obviously, in order to construct the most viable policy, it is advisable to have an understanding of their general ecology in the area where the policy will apply.

The BCNR provides an ideal testing ground for the examination of these issues, since it is a large, protected area surrounded by both subsistence and commercial agricultural ventures, of which, on the escarpment, plantings of pine trees predominate. Baboons are known to cause damage to young pine trees at a commercially significant rate (Bigalke & van Hensbergen, 1990), although this damage is not severe at the BCNR. Since it is possible that utilisation of pine plantations is driven by the local destruction of natural habitat, it is important to determine the extent to, and conditions under, which baboons damage pine trees where they have available to them the full range of natural vegetation.

STUDY AIMS

The aims of this component of the study, accordingly, were:

- To provide data on the population structure and density of baboons in the BCNR);
- To identify a study troop of representative size and to habituate it;
- To determine its annual home range area and patterns of range usage in relation to habitat structure and seasonality, and, lastly;
- To ascertain whether it exploited available areas of commercial pine plantation

RESULTS

Mean troop sizes and population densities

Twenty-one baboon troops, comprising 384 animals were counted on the escarpment section of BCNR over a one-year period (Table. 5.1). The distribution of these troops is indicated in Fig. 5.1. Troop sizes ranged from 9 to 37 animals. The overall mean troop size was 18.3 animals (+/- 6.8 SD) and there was no significant difference in the mean size of troops from differing primary habitat types (ANOVA: $F_{3,17}$=1.35; NS)

Table 5.1: The troop sizes, range areas and population density estimates for baboons on the escarpment section of the BCNR. The Bourke's Luck study troop is indicated in italics.

No	**Troop name**	**Size**	**Range/km^2**	**Density/km^2**	**Habitat**
1	Steenveld	24	12.4	1.94	Mixed bushveld
2	Rietvlei	22	11	2.00	Mixed bushveld
3	Uitval	11	10	1.10	Mixed bushveld
4	Claremont	18	11.2	1.61	Mixed bushveld
5	Aventura	14	3.6	3.88	Mixed bushveld
6	Drie Rondawel	21	9.60	2.19	Protea grassland
7	Leroro	9	5.00	1.8	Protea grassland
8	Lowveld View	11	7.00	1.57	Protea grassland
9	Corner	14	6.00	2.33	Protea grassland
10	Boesman kloof	15	11.10	1.35	Protea grassland
11	Belvedere	25	12.65	1.98	Riverine vegetation
12	*Bourke's Luck*	*18*	*10.35*	*1.74*	*Moist grassland*
13	Goedgeloof	18	10.80	1.67	Moist grassland
14	Muilhuis	37	14.10	2.62	Moist grassland
15	Op de Berg	29	12.30	2.36	Moist grassland
16	Pirrow	11	8.20	1.34	Moist grassland
17	Clear stream	24	11.90	2.02	Moist grassland
18	The Peak	18	10.70	1.68	Moist grassland
19	Waterval spruit	15	10.00	1.50	Moist grassland
20	Heddle spruit	17	11.40	1.49	Moist grassland
21	Pinnacle	14	8.50	1.64	Moist grassland
	Mean values	**18.3**	**9.9**	**1.9**	

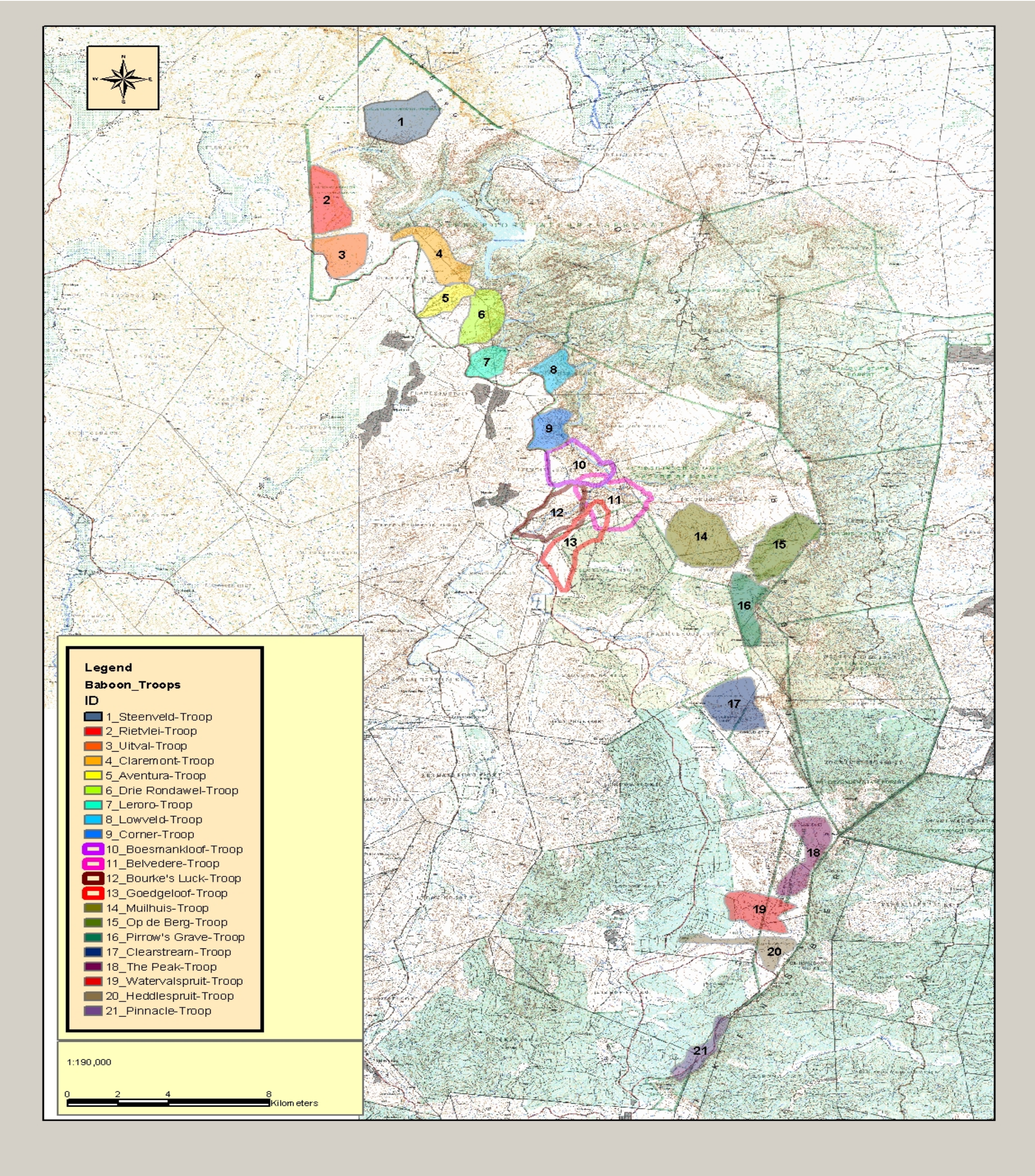

Figure 5.1: Distribution of baboon troops on the escarpment section of the BCNR showing the overlap of the Bourke's Luck troop (#12) with the Goedgeloof troop (#13) and Belvedere troop (#11).

The smallest troop at Leroro, using a tourist residential zone, had a home range area that was significantly smaller than expected for its size (centred leverage value > 0.5) and was excluded from the following analyses, while the Valley and Mixed Bushveld habitats were combined. There was a significant correlation between troop size and estimated home range area (R=0.81; N=20; P<0.01) (Fig. 5.2) Density was calculated as home range area/group size. The mean estimated population density was 1.8 baboons/km^2 (+/- 0.4SD) This, surprisingly, was also positively correlated with group size (R=0.76; N=20; P<0.01) (Fig. 5.2).

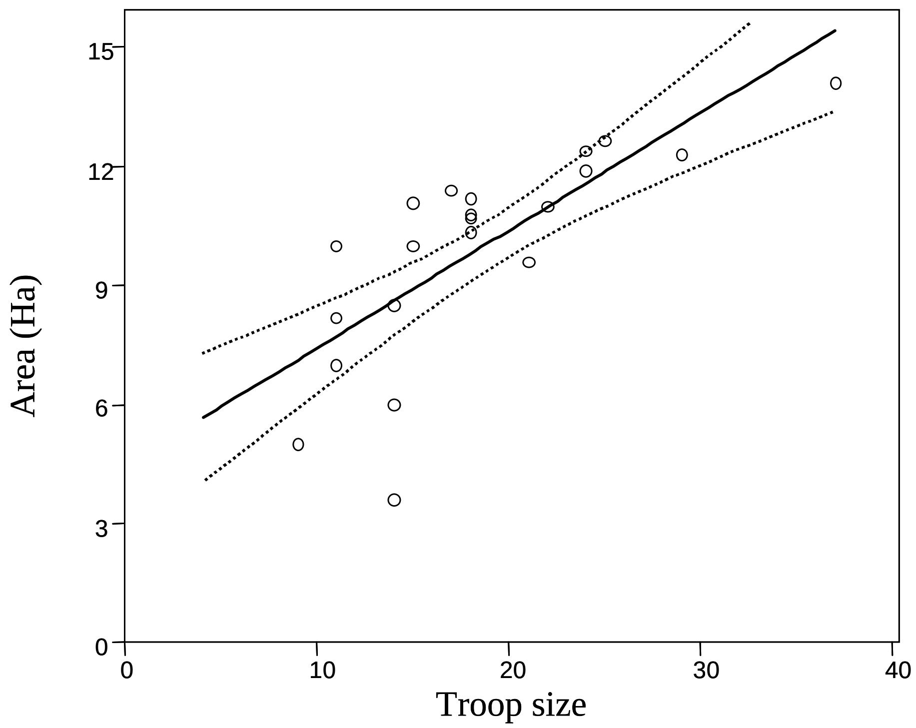

Figure 5.2: The relationship between troop size and home range area (+/- 95% CL) on the escarpment section of the BCNR.

<u>Study troop</u>

The Bourke's Luck troop was subsequently chosen for habituation and detailed data collection since it was of close to average size at the start of the study and utilised a home range that extended at least to the reserve boundary, placing it within reach of pine plantations. Data presented below are from this troop. It consisted of 16 animals at the start of the study in March 2001. No mortalities were recorded during the study period. Troop size increased to 18 animals by the end of the study period in March 2002, as a consequence of the birth of two infants (Table 5.2).

Table 5.2: The population structure of the Bourke's Luck study troop at the end of the study period.

Sex & age classes	Number of animals
Adult male	1
Adult females	4
Subadult male	2
Subadult female	2
Juvenile male & female	6
Infants	3
Total	**18**

Ranging data

Day journey length

The average annual day journey length for the Bourke's Luck troop during the study period was 3.37 km (+/-0.73 SD: N=24) The troop's average daily distance during the dry season was 3.78 Km (+/-0.74 SD: N=12) (Fig.5.3). The average distance travelled per day during the wet season was 2.99 km (+/-0.48 SD: N=13) (Fig. 5.3). Data showed that the Bourke's Luck troop increased its travel distance significantly during the dry season (t_{23}=3.16; P<0.01).

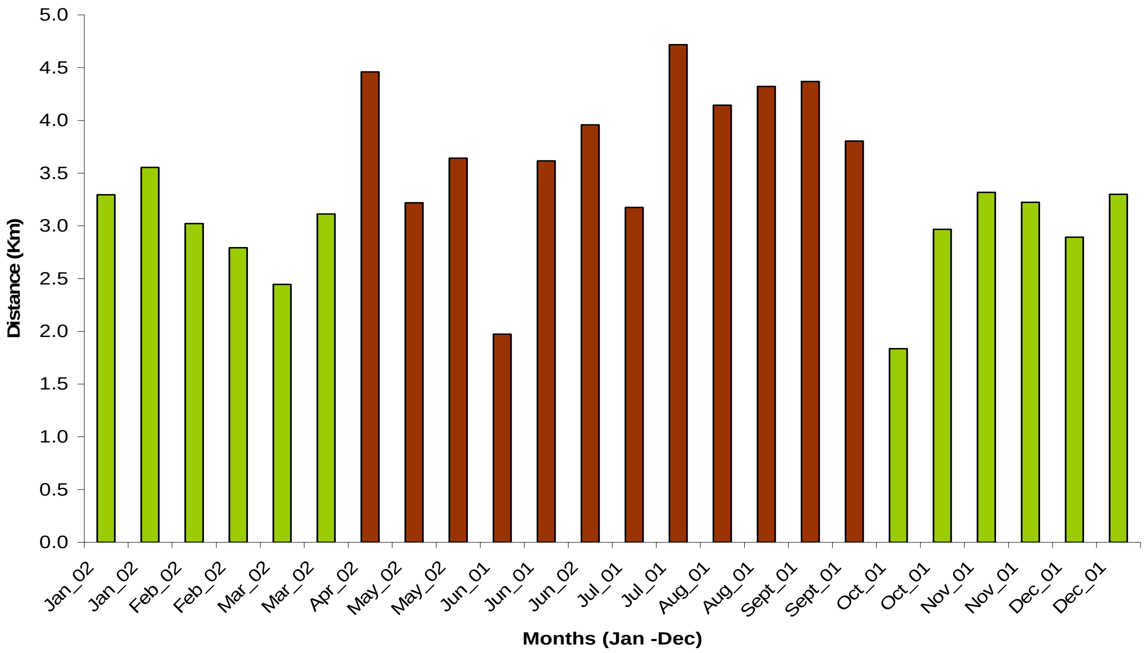

Figure 5.3: Monthly travel distances made by the study troop during the wet season, (October-March) and the dry season (April-September) throughout the study period. (Green represents the wet season and brown the dry season.)

Home range size

The baboons utilised, on average, 34.47 ha per observation day (+/-20.31 SD), resulting in a recorded annual home range size of 10.35 km^2 (Fig.5.4). The mean day range area for the wet season was 31.44 ha (N=13 +/-10.56), while that for the dry season was 52.3 ha (N=12 +/-23.0). This seasonal difference was significant (t_{23}=2.95; P<0.01). The smallest monthly range size for the dry season was less than 50 ha and the largest was more than 150 ha (Fig. 5.5). The smallest monthly range area during the wet months was less than 50 ha and the largest home range size was more than 80 ha (Fig. 5.5). There was, overall, a positive correlation between day journey length and day journey area (r=0.69; N=25; P<0.01).

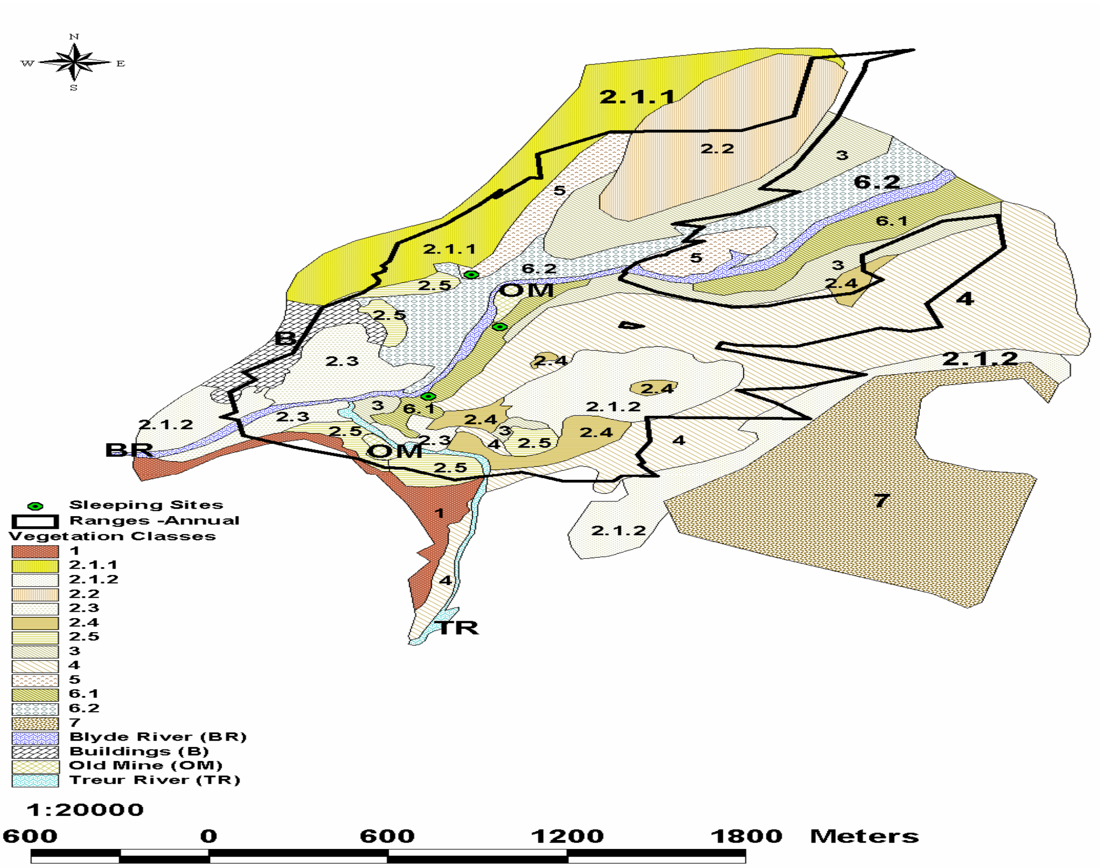

Figure 5.4: The annual home range area of the Bourke's Luck troop, together with the locations of sleeping sites used during the study period.

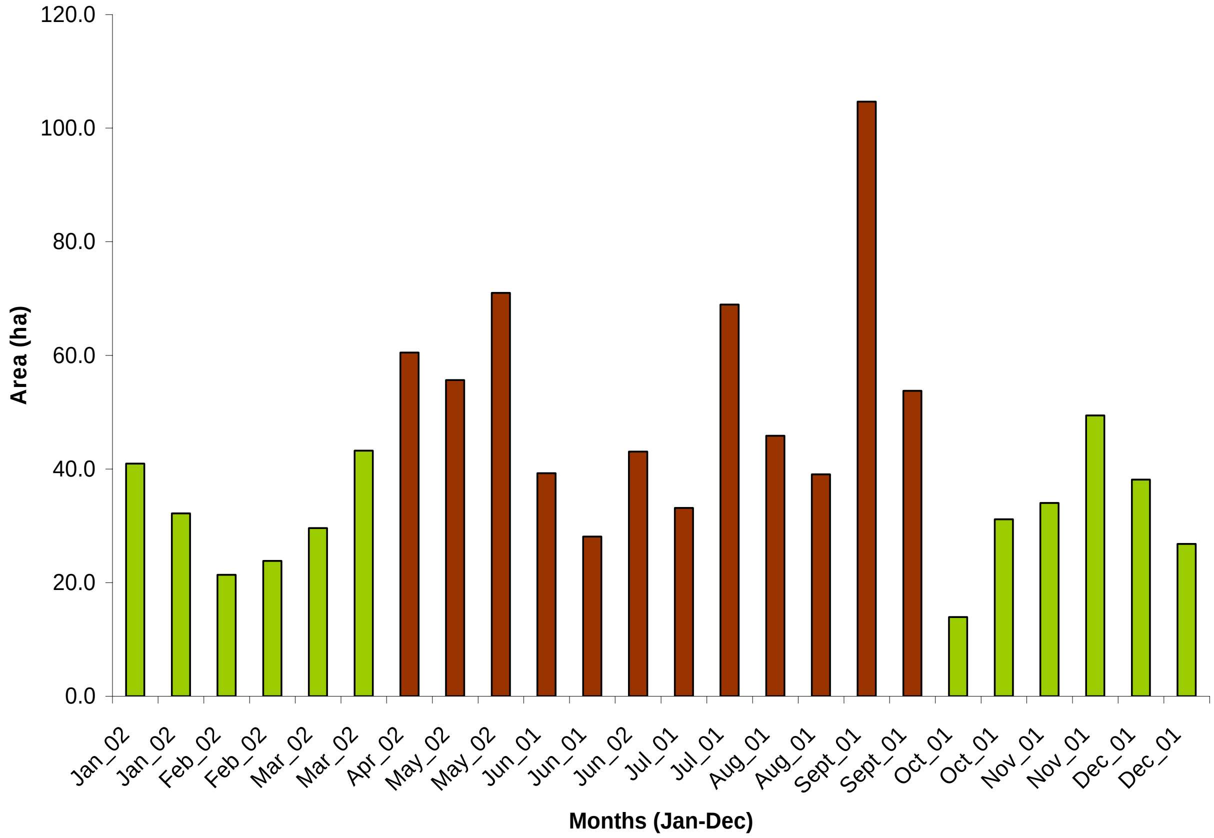

Figure 5.5: Monthly home range sizes during the wet season (October-March) by the study troop and during the dry season (April-September) throughout the study period. (Green represents the wet season and brown the dry season.)

Home range overlap

Two other baboon troops overlapped with the Bourke's Luck troop (N=18) These were the Goedgeloof troop (N=18) on the south-eastern side and the Belvedere troop (N=25) on the north-eastern side of the Bourke's Luck troop's annual home range. The percentage overlap for both troops combined was relatively small at 7,5 % (Fig. 5.1).

Habitat use

The habitat of the study troop at Bourke's Luck consisted of north eastern grassland, type 43 (Bredenkamp *et al.*, 1996) and was subdivided into thirteen plant communities which included seven main plant communities, consisting of four subcommunities and four variants. (See chapter 4.) The topographical outlay of the study area in which the troops home range occurred, varied from gentle to relatively moderate slopes of 2-6° on the higher lying areas to valley bottoms with extreme slopes up to 60°.

<u>Annual habitat use</u>

In this section, the electivity index (EI) (Krebs, 1989) (see chapter 3), was used to ask whether the study troop occupied plant communities only in relation to their contribution, (as a percentage) to the total area utilised by the troop, or whether some communities are preferred and others avoided (Fig. 5.6).

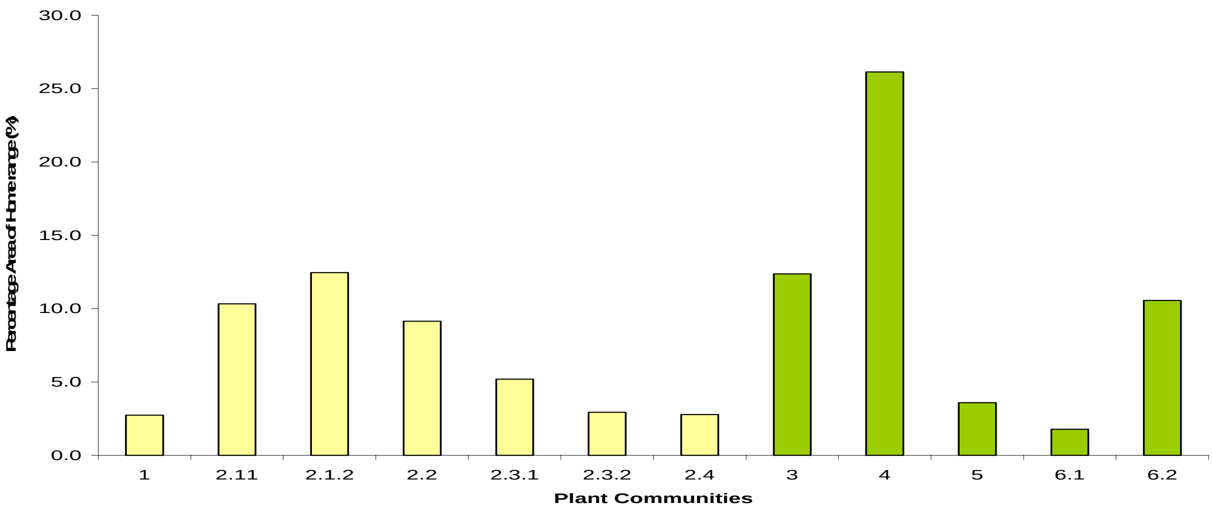

Figure 5.6: The percentage coverage of the various plant communities in the study troop's annual home range (1-2.4 Grassland & 3-6.2 Woodland)

Overall, the electivity indices revealed that habitat use was not uniform over the year; the baboons showed distinct preferences for certain plant communities and avoided others (Fig. 5.7). In particular, there was a very high preference for the *Englerophytum magalismontanum-Acacia ataxacantha* woodland, subcommunity 6.1, which is one of the smallest plant communities present at Bourke's Luck, covering an area of only 9.3 ha. The baboons also showed a preference for *Combretum kraussii-Acacia ataxacantha* woodland subcommunity 6.2, which covers a relatively large area 55 ha (Fig 5.6). Together, these findings suggest that the baboons are attracted to areas of Acacia woodland. This will be investigated in the following chapter. The *Faurea saligna – Cymbopogon vallidus* woodland community 5 was slightly less preferred than the other woodland communities, but still utilised throughout the year (Fig.5.7).

The next most preferred habitats consisted of grassland and shrubland sub communities 2.3 and 2.4. The least preferred communities were the *Hyperthelia dissoluta-Heteropogon contortus* community 1 and the *Helichrysum wilmsii – Panicum natalense* subcommunity 2.2. Subcommunity 2.2, in particular, was strongly avoided (Fig .5.7). Again, the dietary reasons underlying the avoidance of these communities will be investigated in the next chapter.

The remaining communities, 2.1, 3 and 4, were used slightly less than expected as shown by the negative electivity index values. However, the index values here were relatively low compared to the value for communities 1 and 2.2, and the baboons' behaviour could be considered as neutral relative to these habitats. In other words, they neither greatly preferred nor avoided these communities (Fig. 5.7).

According to these overall patterns of the electivity index, it is clear that the baboons actually preferred the woodland communities to the grassland communities on an annual basis, even though the woodland communities cover a much smaller area than the grassland communities do (Fig. 5.6).

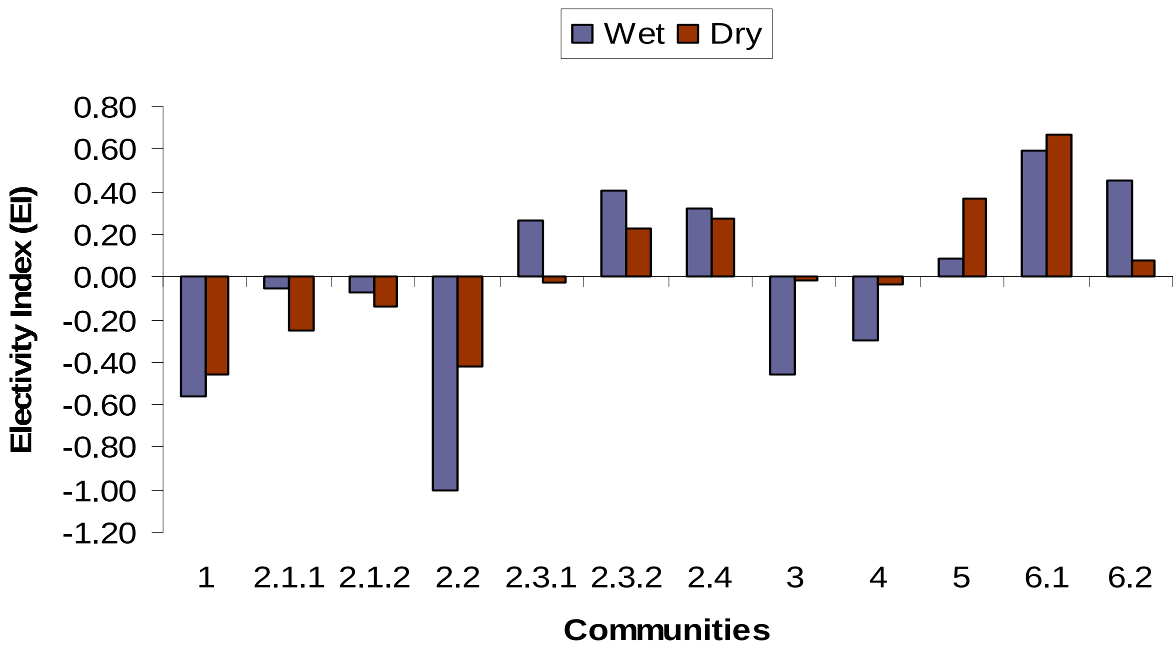

Figure 5.7: The electivity index (EI) for the dry and wet seasons indicating seasonal preference to certain communities by the study troop throughout the study period. (Positive values indicate preference.)

Seasonal habitat use

The electivity indices revealed that habitat use throughout the year was not uniform and that some of the communities were preferred more than others between seasons (Fig.5.7). Generally the communities all had positive (EI) values which meant that they were either preferred or not and not season specific. Variant 2.3.1 was the closest to having both a positive and a negative (EI) value, but the value for the dry season was so close to zero that it was not avoided but utilised relative to its availability in the home range (Fig. 5.7).

Two of the communities and three variants of the following communities (1, 2.1.1, 2.1.2, 2.2.3 & 4) were not preferred by the study troop throughout the year, during both the wet and dry seasons, some were preferred less than the others. Three communities and one subcommunity (1, 2.2, 3 & 4) were preferred less during the wet season and two of the variants (2.1.1 & 2.1.2) were preferred less during the dry season (Fig. 5.7). The subcommunity 2.2 was avoided during the wet season (Fig. 5.9) and not visited by the baboons and was typical of grassland communities where grass roots and other grassland species were foraged on during the dry season only. This is why this subcommunity is the least preferred community during the wet season.

One variant and one community and three subcommunities (2.3.2, 2.4, 5, 6.1 & 6.2) were preferred by the study troop during the wet and dry seasons.

Two variants and two subcommunities (2.3.1, 2.3.2, 2.4 & 6.2) were preferred during the wet season and one community and one subcommunity 5 & 6.1 were preferred during the dry season (Fig. 5.8 & 5.7). Community 6 included subcommunities 6.1 & 6.2 and was overall the most preferred community. This community is located in the centre of the home range (Fig. 5.9), consist of riverine and indigenous evergreen forests, and host most of the woodland species in the home range of the Bourke's Luck troop. (See chapter 4.) This area was also used as a refuge during thunderstorms and extreme heat and contains the largest water source in the home range. The Blyde River is located here and divides subcommunities 6.1 & 6.2 in two sections (Fig. 4.1).

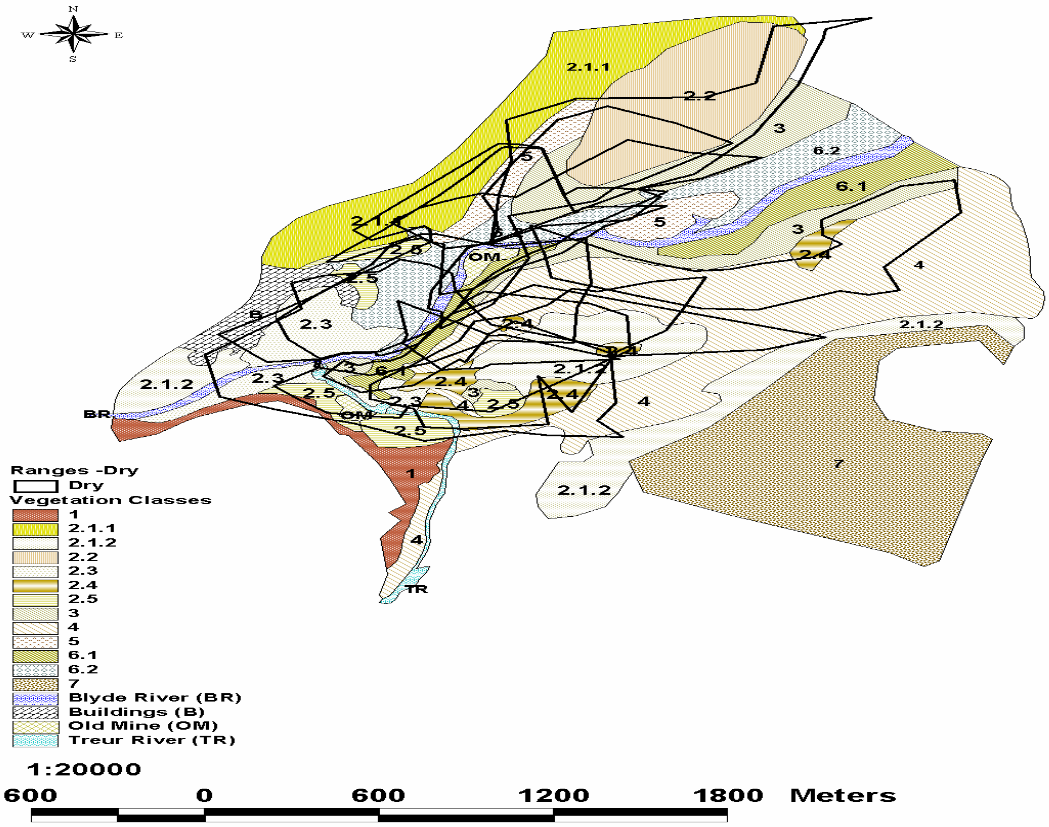

Figure 5.8: The day ranges of the Bourke's Luck troop showing the coverage of the various vegetation classes during the dry season.

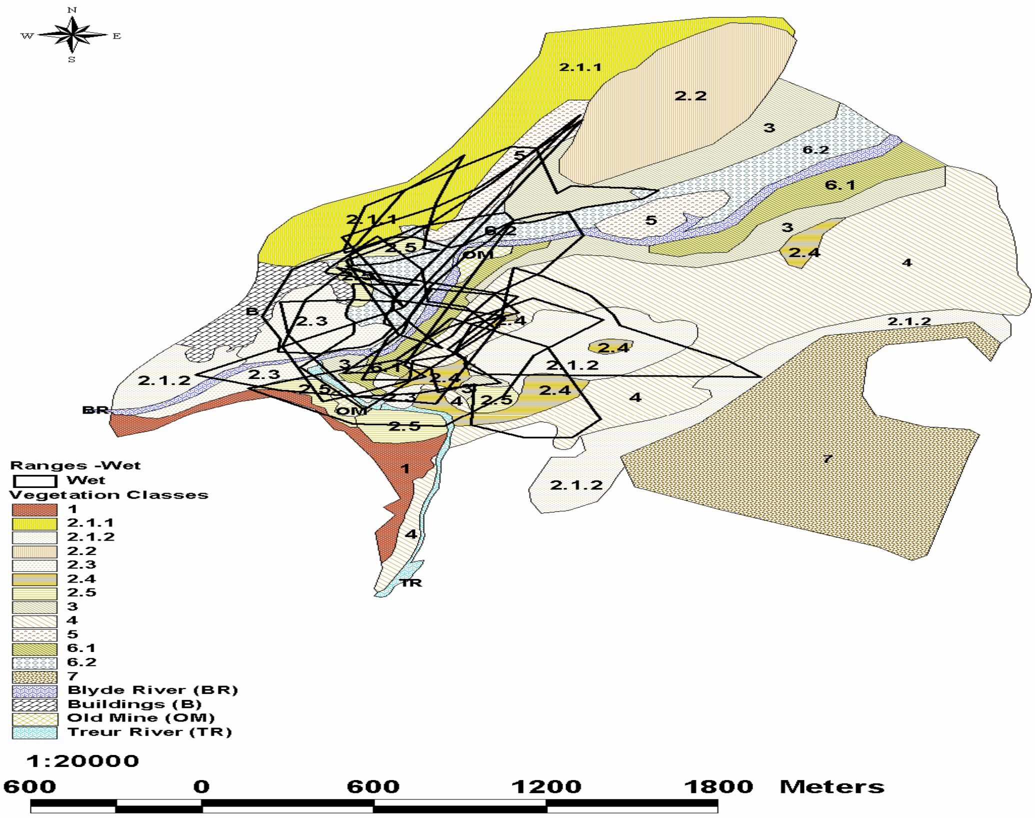

Figure 5.9: Day ranges of the Bourke's Luck troop showing the coverage of the various vegetation classes during the wet season.

The electivity indices for communities 2.3.1, 3 & 4 were close to zero during the dry season, indicating that these communities were not avoided but utilised in relation to their availability in the home range. Generally, the woodland communities were used in preference to grassland communities (Fig 5.6).

Activity budget

The availability and dispersion of core resources are a primary influence on baboon time budgets and determine the extent of the commitment to foraging. The data revealed that, overall; the troop allocated more of its time to foraging than to any other activity.

The baboon troop spent on average 62% of their time during a one-year period foraging for various food items like roots, fruits, seeds, leaves, stems, insects, flowers and pods. Walking took a lot of their time and kept them busy on average 24% of their time. Resting came to 10% of their time and socialising at 5% (Fig. 5.10). They often rested before going to their sleeping site at night or when they emerged from their sleeping site in the mornings, they used four sleeping sites that were situated on the cliffs of the canyon. The baboons often rested during the heat of the day or during heavy rainstorms.

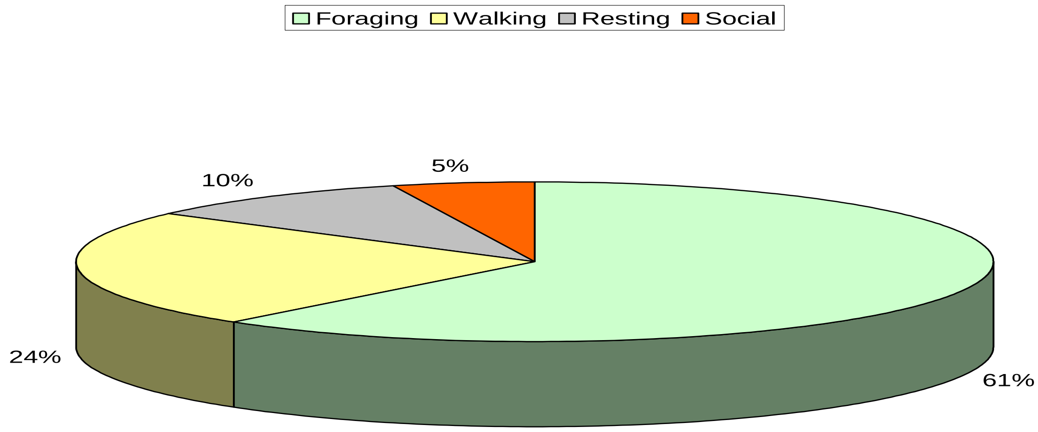

Figure 5.10: The activity budget of the adult baboons of the study troop throughout the study period including four categories (foraging, walking, resting, social).

DISCUSSION

Comparison with data from other chacma study sites (Henzi & Lycett 1995; Hill 1999, Watson, 1985; Gaynor, 1994; Stoltz & Saayman,1970; Davidge, 1978) reveals that in their low densities, small mean group size, high investment in foraging and food search strategies that result in relatively short day ranges, the BCNR baboons bear the closest resemblance to the Drakensberg mountain population (population density – 2 Ind/km^2, Mean group size = 21.4; percentage time feeding = 68%; mean day range = 4.6 km. (Henzi & Lycett 1995; Henzi *et al.*,1997) Together, these two populations are outliers in a subspecies that is, itself, characterised by small group sizes and high foraging demands. (Henzi *et al.,* 1999) The similarity is not surprising since both populations are subject to the direct and indirect effects of the elevation and relief of the Drakensberg escarpment, which result in high thermal demand and low food availability, at least in winter. (Henzi *et al.*,1992)

Unlike the Natal Drakensberg population, though, the BCNR baboons forage in an environment that, by virtue of its lower latitude, is characterised by a much greater variability of habitat types within the home range (Henzi *et al*., 1992) and the results indicate that this corresponds to a greater variability in utilisation, with a particular, but not surprising, preference for woodland, as this is likely to yield a better return for foraging effort. (Hill & Dunbar, 2002) Although diet will be considered more directly in the next chapter, there are two issues that can be pursued now.

The first is that the baboons clearly employ two different modes of engagement with their home range that is conditional on where they choose to forage on any one day. Successful foraging in grassland requires careful searching for cryptic food items and results in uniform, slow travel speeds and small day ranges (Henzi *et al.,*1992, Henzi *et al*.,1997), whereas utilisation of woodland generally involves greater variation in travel speed and distance travelled as animals move to a foraging area where they can subsequently obtain necessary resources in a small, circumscribed zone. (Gaynor, 1994) The general correlation found between day journey length and day journey area masks an additional relationship between the absolute size of the standardised residual and day journey area that supports this (Fig. 5.11)(Rho=0.69; N=25; P<0.01).

(Fig. 5.11) Indicates that longer day journeys, a characteristic of the dry season, were associated with the exploitation of either very small or very large areas. In our reading, and given the absence of seasonal effects in activity patterns, this suggests that the baboons were both moving and foraging consistently but slowly in small areas of grassland or moving rapidly over some distance (hence a large, positive residual) and then increasing their intake rate rapidly within a circumscribed area of relatively high food availability. The point is that the actual foraging zone of the troop – once travel is factored out – is always likely to be relatively small. Sample size prevents me from investigating this but it remains a topic for further, more detailed analysis that considers exploitation in relation to the mix of habitat types encountered.

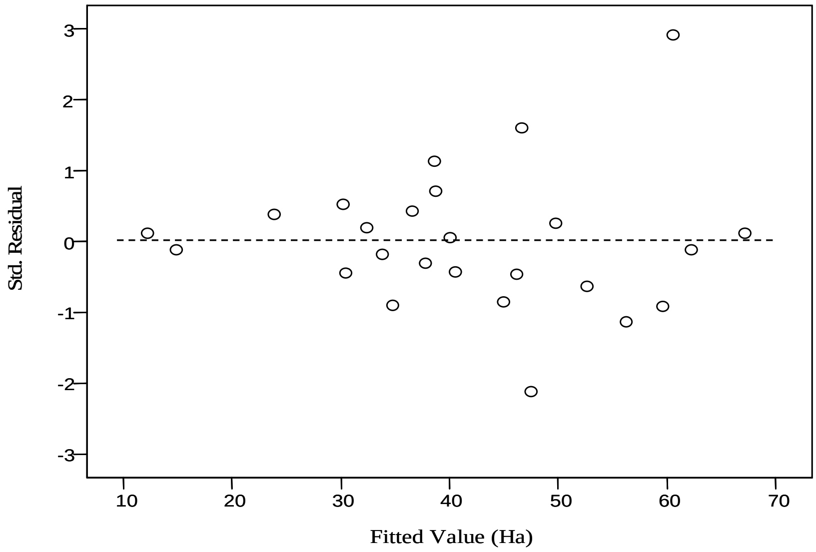

Figure 5.11: The relationship between the estimated values of day range area and the standardised residuals.

The second issue is that – despite the damage that they cause elsewhere – the study troop chose to avoid an easily accessible pine plantation. This avoidance, especially given the positive correlation between group size and number of group members/km^2 that suggests some local crowding, is telling and confirms Strum's point (1994) that raiding by baboons is not inevitable, nor is its occurrence predictable from gross local features. One or both of two possible reasons suggest themselves: either the baboons have available to them outside the plantation all the keystone resources they need or they target only forestry compartments of particular age/size classes. Determining how these alternatives might interact requires comparative data and we have now expanded the study to include troops that do make use of plantation. Results will be reported elsewhere.

Lastly, one implication for conservation policy stems from the similarity of the BCNR baboon profile to that of the Drakensberg population. Long-term data from the Drakensberg reveals that recruitment to the baboon population is low, with female reproductive rate constrained by climate. (Henzi & Lycett, 1995; Lycett; Henzi & Barrett, 1998) If, as seems likely, baboons of the Mpumalanga escarpment have comparably long inter-birth intervals, then the current forestry management practise of extirpation may reduce the long-term viability of baboon populations in protected areas.

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CHAPTER 6

DIET SELECTION

INTRODUCTION

The results presented in chapter 5 indicate that the baboons did not use all plant communities within their home range equally, expressing, overall, a preference for those broadly classified as woodlands. The complete avoidance of pine plantation suggests either that the baboons could obtain the nutrients potentially proffered by the plantation more efficiently in natural habitat (or that a greater array of nutrients was available outside the plantation at all times of year) or that the demographic structure of the pines in this plantation (age-class, for example) presented few resources. Answering the second of these will require comparative data from other sites along the escarpment but some progress can be made by considering more precisely what it was that the baboons did use, both in terms of species and at the level of food type. This is the focus of this chapter.

Baboons are characterised as eclectic but highly specialised feeders. (Whiten *et al.,* 1987) They consume a wide variety of plant species but may only eat a single part, ingesting only the flowers, seeds or leaves of each one. (Barrett, 2000) This broad-ranging diet enables baboons to inhabit a wide variety of habitats, especially given their ability to dig and thereby gain access to subterranean plant parts such as corms, bulbs and tubers. These foods are less easily available to other open country species, such as antelope and warthog. The ability to access underground food items, in particular, allows baboon populations to occupy habitats of otherwise low productivity, such as, for example, the Drakensberg Mountains (Henzi *et al*., 1997) and coastal fynbos (Hall, 1962; 1963; Davidge, 1977; 1978), as well as to cope with seasonal fluctuation in food availability.

As well as plant foods, baboons supplement their diet with animal protein obtained from insects, reptiles and occasionally small birds and mammals. They are best characterised as omnivores, but in more productive habitats, baboons show a preference for fruit over other kinds of foods. (Dunbar, 1988) Interestingly, meat eating is most prevalent in poor quality habitats, where the increased costs of obtaining animal foods are outweighed by the increased benefit from the inclusion of high-quality protein in the diet. (Dunbar, 1988)

Clearly, the specifics of baboon diet and choice in any one area are determined by local habitat structure and the array of available food species it contains. Tying these to general concerns about food choice requires an understanding of how this array translates into the provision of an adequate diet, especially during 'crunch' months. It is known from work in the Drakensberg (Henzi *et al*., 1997) that the absence of time budget effects may mask large differences in food availability and nutrient intake. In this chapter, diet selection were considered by the Blyde River Canyon baboons in the context of seasonal variability. The food species and seasonal shifts were described in the extent of the diet and use of various food types. These data were assessed in relation to the preferential use of some plant communities and the avoidance of pine plantation.

RESULTS

Annual diet selection

The baboons foraged on 67 different plant species during the study period. These included 6 grass species, 26 forbs and 35 shrub and tree species. (Annexure A) In addition to this wide variety of plant species, they fed on insects, of which the only ones identifiable were locusts, throughout the year. The diet depended on the distribution and availability of plant species, with some species clearly being preferred over others. If the plant types were divided into two primary categories – woody and herbaceous (including grasses) then trees and shrubs have significantly higher EIs than do herbs and grasses (Kolmagorov-Smirnov Z=2.22; N_{woody} = 35; N_{herb} = 32; P<0.001). This is illustrated in Fig 6.1. Interestingly, 48 of the 67 food species have EIs in excess of 0.5 (Fig 6.2). If we assume an even distribution of EIs, this skew is highly significant (CHI^2 = 77.5; 1 df; P<0.001) and supports the general observation that, while eclectic, baboons are selective foragers. When the diet is considered in terms of the parts of plants species that are utilised, it is clear (Fig. 6.3) that there is an overall preference primarily for fruits and then flowers.

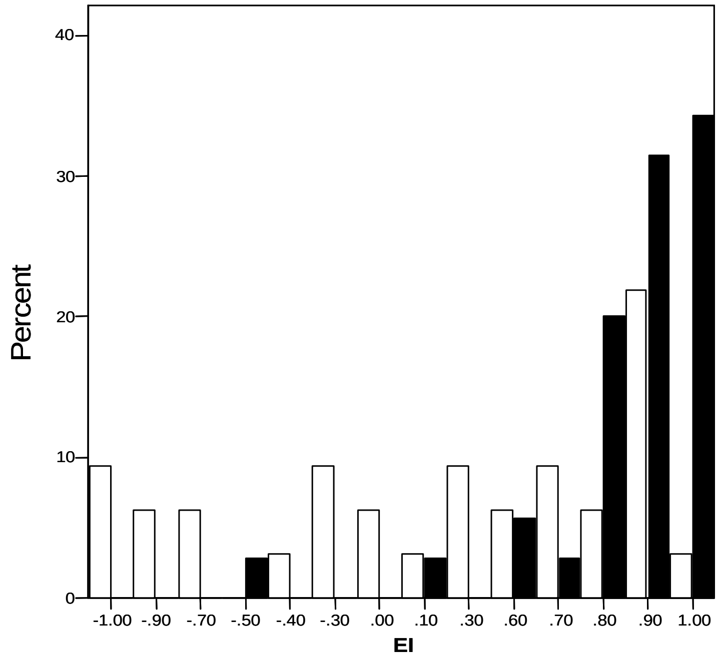

Figure 6.1: The electivity indexes for woody (solid bars) and herbaceous (open bars) plant species measured as a percentage of each category.

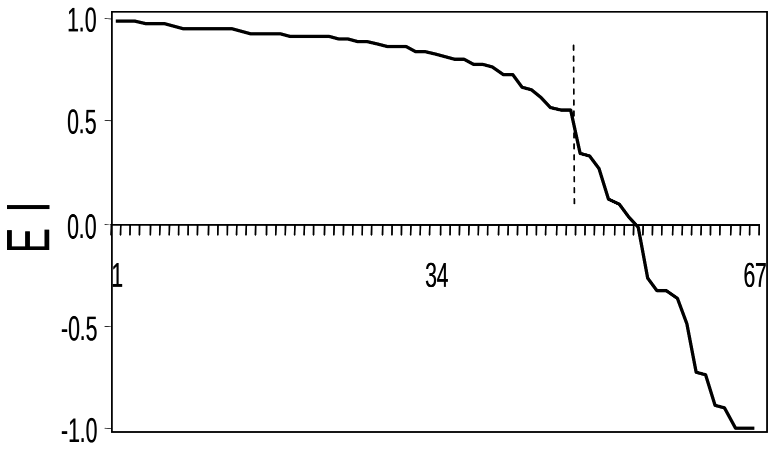

Figure 6.2: EI ranking of all 67 food species.(The dashed line identifies the point at which the EI falls below 0.5)

Fruit species made up a large portion of their diet and accounted for 62% of the total forage effort. Fruit were eaten when they were ripe and the baboons were not observed to eat green fruit. Flowers were the second most preferred food item and accounted for 16% of the total foraging effort. Flowers were fed on during both wet and dry seasons. Pods, leaves, roots and insects each made a very small contribution to the diet (all less than 10% of foraging time). Pods and leaves were fed on regularly only when green. Stems and bulbs accounted for less than 1% of total foraging effort (Fig 6.1).

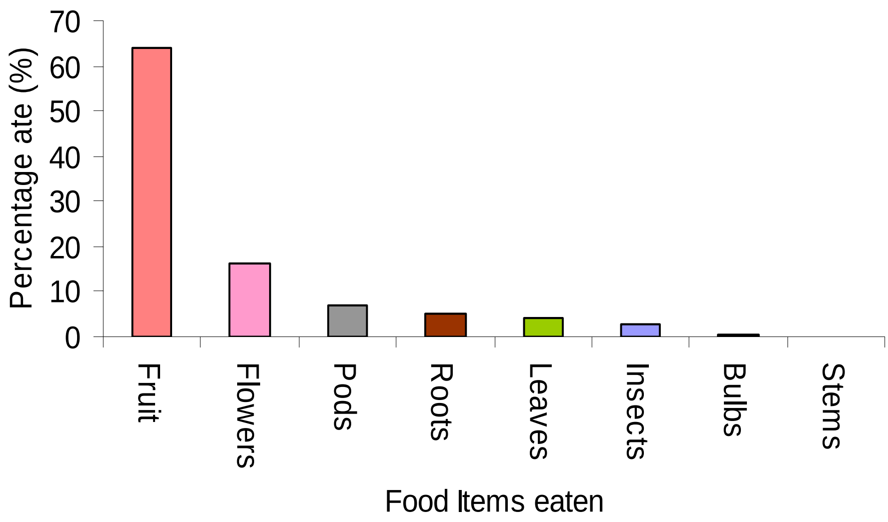

Figure 6.3: Annual foraging effort allocated to various food types.

Seasonal differences in diet selection

Of the 67 different species, 59 were utilised during the wet season and 26 during the dry season. Ten were utilised in both seasons, largely because of overlap in fruiting and flowering times. These were fruit of the tree species *Ziziphus mucronata* and *Syzygium legatii,* the flowers of the forb species *Chamaecrista mimosoides, Hemizygia transvaalensis* and *Hemizygia parvifolia,;* the pods and roots of the forb species *Crotalaria doidgeae,;* the flowers and leaves of the tree species*, Dalbergia armata, Pterocarpus angolensis* and *Mundulea sericea,* as well as the pods of *Acacia ataxacantha.*

As with annual electivity, shrubs and trees had higher electivity indexes in the wet season (Kolmogarov-Smirnov Z = 2.15; N_{woody} 30= ; N_{herb} = 29; $p<0.001$) but not in the dry season (Kolmogarov-Smirnov Z = 0.7; N_{woody} = 14; N_{herb} = 12; NS) This is illustrated in Fig. 6.4. Comparison of the EIs of herbs and grasses across the two seasons indicates that the distributions differ significantly (Kolmogorov-Smironov Z = 1.36; N_{wet} = 29; N_{dry} = 12; $p<0.05$), such that the fewer species used in the dry season have larger electivity values (Fig. 6.5). This is not the case for tree species (Kolmogorov-Smironov Z = -0.11; N_{wet} = 30; N_{dry} = 14; NS).

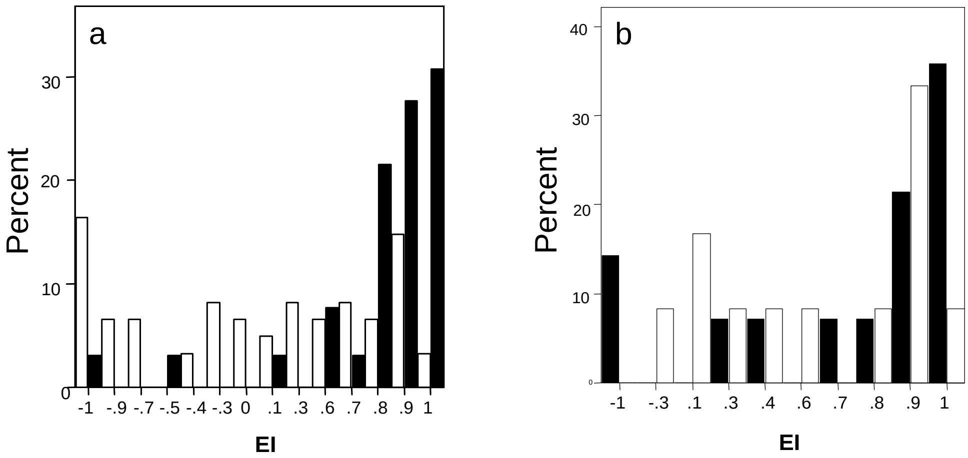

Figure 6.4: Electivity indexes for woody plants (solid bars) and herbs/grasses (open bars) in (a) the wet season and (b) the dry season.

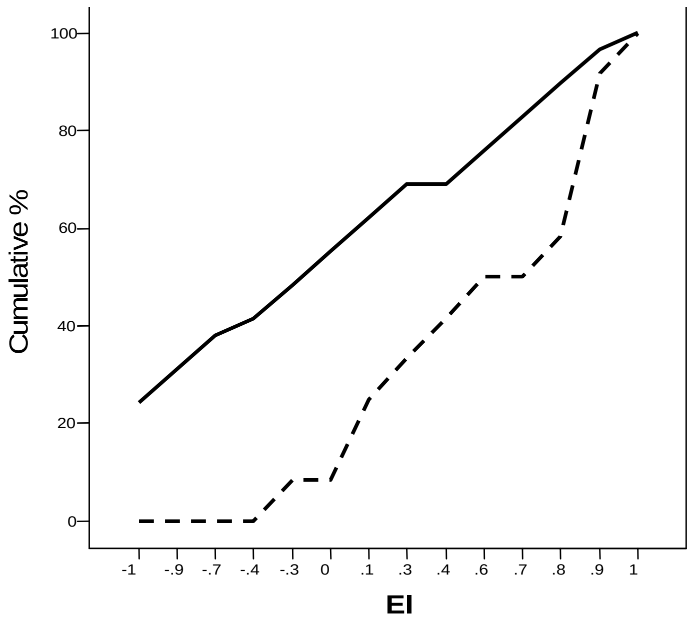

Figure 6.5: Weighting of electivity values of the herbaceous component of the diet in the wet (solid line) and dry (dashed line) seasons.

Cross-seasonal comparison of the utilisation of various food types (Fig. 6.6) reveals an increased reliance on pods and roots in the dry season, compensating for a decline in the availability of fruit and flowers.

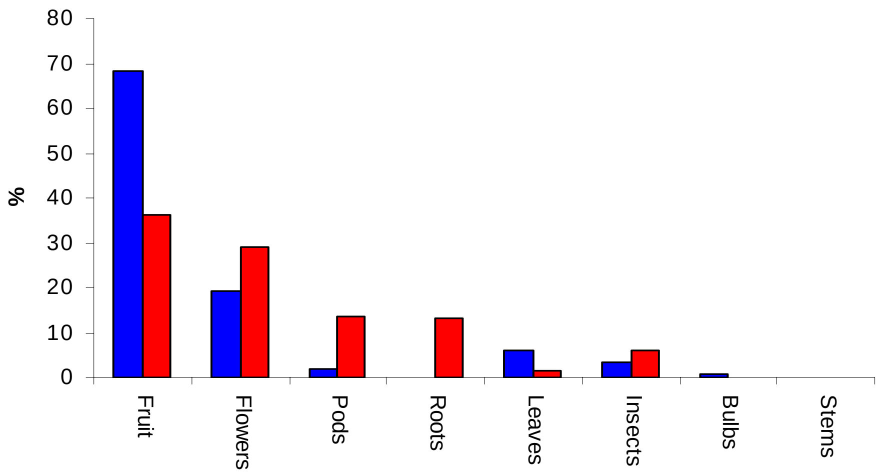

Figure 6.6: Foraging time allocated to various food items during the wet (blue bars) and dry (red bars) seasons.

DISCUSSION

The data in this chapter indicate that, as at other sites, the baboons eat a wide array of food types, utilising not only the tree and herb layers but also grasses and underground items. The data also show, however, that the actual number of species used is restricted to a small subset and that these species are actively sought out (Fig. 6.2). The Blyde baboons, therefore, conform to what we know of populations elsewhere, matching Whiten *et al.,*'s (1987) description of *Papio* as being both eclectic yet highly selective. Although this selectivity extended beyond fruits and flowers to include herbs and grasses, it is clear that the mainstay of the diet was provided by woody plants, with herbs and grasses included in the dry season diet only if highly preferred.

This restriction of the diet to relatively few prized items was presumably made possible by the mosaic nature of the plant communities within the home range and the alleviating effects, presumably, of the moisture from the rivers on the gorge vegetation. In support of this, all of the preferred communities occurred on the lower lying wet areas (Fig. 4.1) in the gorges, canyon and rocky outcrops. We can see much the same outcome from the Umfolozi data provided by Watson (1985) where his baboons similarly occupied a mosaic habitat adjacent to the Umfolozi river (Fig. 6.7).

As with the Blyde baboons, his animals showed some dietary adjustment to the dry season, namely the inclusion of stems and a greater reliance on tubers. Nevertheless, there was no marked shift to underground items, as recorded in habitats where there is less heterogeneity. (Drakensberg, Whiten *et al.,* 1987; De Hoop, Hill, 1999; Cape Point, Davidge, 1978)

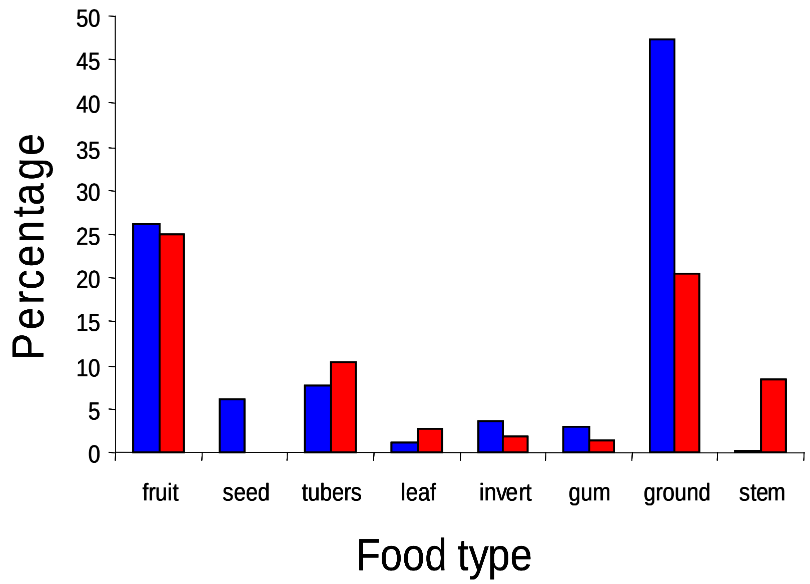

Figure 6.7: Seasonal variation in foraging time allocated by Umfolozi baboons to various food types. The data were calculated from Table 6 in Watson (1985) 'Ground' refers to otherwise unidentified food items picked up off the ground.

Habitat heterogeneity, possibly in conjunction with permanent water, made it possible for baboons to limit the inclusion of low quality foods (or those that are difficult to harvest) in the diet by preferentially occupying plant communities.

characterised by extensive tree cover and diversity. As flowers and fruit made up the highest percentage of the baboon troop's diet (Fig. 6.3), the variety of tree, shrub and forb species present in some preferred communities may explain preferential utilisation by the baboons, despite the high percentage of grass cover. A number of the dominant plant species, such as *Diospyros lycioides, Euclea linearis* and *Pearsonia sessilifolia,* were extensively used as were other prominent and diagnostic species like *Hemizygia transvaalensis. (*See chapter 4.) Further support for the suggestion that the baboons were attracted to these communities by the presence of fruit trees is given by the fact that other preferred plant communities (#5, 6.1, 6.2) had low grass cover of between 0-40 % but tree cover of 65-100 %. (See chapter 4.)

At Blyde, this preference for some plant communities was reflected in the patterns of movement by the study troop (chapter 5), where the increasing day lengths characteristic of the dry season were associated with an increase in the magnitude of the residuals. As I argued in Chapter 5, this pattern of movement conforms to one where animals are moving from one zone to another and then foraging intensely in a restricted area (see also Gaynor, 1994). Such habitat utilisation contrasts, for example, with that seen in the Drakensberg, where low heterogeneity results in a much more even occupation of the home range. (Henzi *et al*., 1997)

Of course, none of this means that the animals were able to sustain the same quality of diet across the seasons. It may well be that they made the best of a bad job by concentrating on food items that are intrinsically high quality but that they, nevertheless, operated as 'time minimisers' during the dry season, as is suggested by the similarity of the time budgets in the two seasons. (Chapter 5) It is not possible to gauge this without some idea of intake rates and the nutritional characteristics of dietary items (e.g. Byrne *et al*., 1993) Alternatively, some means of weighing the animals would provide the best measure as to the quality of the dry season diet. The climate alone would suggest that the baboons are subject to increased thermal stress during the colder dry season and that the low population density of the study site reflects the effect of this on dietary quality.

The important point, however, is not whether the animals obtained sufficient food during the dry season but the fact that they persisted in foraging selectively for high quality items, ignoring a range of food items, such as sedge roots and bulbs, that are known to be present and that make up a much larger fraction of the diet of Drakensberg baboons, for example. (Whiten *et al.,* 1987; Byrne *et al.,* 1993) This has immediate implications for the observation that they avoided a large, local pine plantation. (Chapter 5) Pine plantations are characterised by low species diversity and it is likely that they also provide baboons only with low quality resources. If so, it would not make economic sense for a troop to spend time there provided that the other indigenous communities were both internally heterogeneous as well as with respect to one another. At Blyde, woodland communities were generally preferred over pure grassland and it is noteworthy that the former generally consisted of 25 or more species per $200m^2$, whereas the latter consisted of no more than 13 species. (Chapter 4)

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CHAPTER 7

CONCLUSION

The objectives for this study were successfully attained. More information has been provided on how baboons live in north-eastern mountain sourveld and what they forage on.

The plant communities on the Bourke's Luck section – the study troop's home range and distribution – were successfully identified, described, classified and ecologically interpreted, resulting in a detailed vegetation map. From these detailed descriptions, it emerged that the home range consisted of a broad variety of habitat types distributed in a complex mosaic vegetation pattern.

The various plant communities matched the broader vegetation types of the BCNR and will be used in the biological management plans of the reserve. Consequently, the descriptions of the study troop's home range compare well with descriptions of other study areas and some of these plant communities show association to the Drakensberg vegetation, as well as affinity to the Bankenveld vegetation.

These plant communities also fall within the Wolkberg centre of endemism and a number of endemic plant species were identified within these communities, and several new species were added to the inventories of the BCNR. The Braun-Blanquet approach again proved to be an accurate and effective way of identifying, describing and classifying floristically defined plant communities.

The baboon troops on the escarpment section of the BCNR were successfully identified and counted and the method used proved to be effective. The troop sizes of the baboons on the escarpment section of the reserve proved not to be unnaturally high and were similar to troop sizes in other similar natural vegetation types, especially those in the Natal Drakensberg occurring in similar vegetation. The baboon troops on the escarpment section of the reserve showed a positive correlation between troop size and estimated home range area. This means that the larger the troop size, the larger the home range.

The methods used to collect activity and foraging data on the Bourke's Luck troop during the study period were successful and enough quality data could be collected to determine the troop's home range sizes, journey lengths and the plant species utilised during various seasons.

The detailed vegetation descriptions were used to determine the selectivity of the various plant communities and subcommunities by the study troop throughout the study period.

It was found that the baboons utilised specific plant communities and subcommunities differently throughout the study period and that the seasonal differences in home range sizes and day journey lengths were significant. Data collected shows that there is a difference in the preference for plant species utilised by the baboons during the dry season comparied with the wet season, as well as a difference in the number of plant species they eat per season.

The study troop generally utilised more plant species during the wet season than the dry season and utilised these species relative to their availability in the habitat. The plant species the baboons utilised during the dry season were far less diverse than those utilised in the wet season and they concentrated heavily on the species available, eating them far in excess of their representation in the habitat.

The baboons preferred to forage on fruit rather than any other food source available. They preferred to forage on fruit from fruit bearing tree species and this is why they preferred the woodland communities to the grassland communities. This is also why they preferred those woodland communities that had a high relative availability of fruit bearing trees over the other communities.

The home range sizes between the dry and wet seasons were significant owing to the search for food during the dry season, which resulted in extended home ranges and day journey lengths during these periods.

Management considerations regarding the baboon populations on the escarpment section should not be considered at this stage, because the troop sizes are not unnaturally high. Regarding the management of the vegetation component it is important to determine the management objectives.

If it is decided that the Bourke's Luck section will also be managed for baboons, consideration must be given to the fire management of these areas. The current burning programme makes provision for the complete area, including the study troop's home range, to be burned on a two-year cycle. This results in the plant communities that are elected by the baboons during the dry season all being burned, which places the baboons under extra stress to find food. This may result in them foraging in the areas adjacent to the reserve, causing damage to commercial forest plantations and crops. The vegetation data also indicates that a longer fire frequency of every three to four years would be more suitable in terms of species richness. The use of patch burns or early spring burns may be more beneficial to the baboons and the larger communities should be divided into two sections, each of which each would be burned every three to four years.

Where these communities exist in other areas in the regions where baboons occur, they should also be managed in such a manner to ensure that the baboons have enough food available throughout the year. This would lessen the risk of baboons moving onto adjacent areas in search of food and causing damage.

Regarding the damage to pine plantations, is it important to conduct a study on a baboon troop in the area that lives within these plantations to determine their foraging patterns and social behaviour, and also which natural plant species are still available to them. This data could then be compared with the results of this study. Management strategies could then be implemented to lessen the damage caused by these animals on an ecological basis based on scientific data. It would also be important to research the reasons the baboons eat the bark of the pine trees and also whether or not they prefer specific age classes.

The contents of this study would prove valuable in developing management strategies for baboons in natural areas and could also be used in similar studies of this nature.

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Annexure A: A list of all the plant species and parts foraged on by the study troop throughout the study period. ((fr) Fruit, (st) Stem, (fl) Flower, (lv) leaf, (pd) Pod, (rt) root)

Species	**J A N**	**F E B**	**M A R**	**A P R**	**M A Y**	**J U N**	**J U L**	**A U G**	**S E P**	**O C T**	**N O V**	**D E C**
Acacia ataxacantha(pd)				X	X	X	X				X	
Acacia siberiana (pd)						X						
Aeschenomene leptobotra(fl)										X	X	
Aloe arborescens(lv)(st)								X				
Aloe dewetii (lv)											X	
Aristida junciformes(rt)				X								
Bulbulstylis burchelli (rt)					X							
Canthium inerme (fr)		X										
Canthium mundianum(fr)			X									
Cephalantis natalensis (fr)												X
Chameacrista mimosoides(fl)			X		X							
Commelina africanus(fl),	X											
Commelina bengalensis(fl)	X											
Crotolaria doidgeae(rt)(pd)(fl)			X	X	X	X	X	X				
Cussonia paniculata(lv)(st)			X								X	
Cussonia spicata(lv)												X
Cyanotis speciosa(st)												X
Dalbergia armata(pd)				X	X							
Diospyros lyciodes sericea (fr)	X											
Diospyros lyciodes(fr)	X	X	X									
Diospyros wyteaena(fr)			X									
Ekebergia pterophylla(fr)		X										
Englerophytum magalismontanum(fr)	X	X										X
Eragrostis acrea(rt)					X							
Erythroxylum emarginatum(fr)												X
Euclea dewintri(fr)	X											
Euclea linearis(fr)					X	X	X	X				
Fadogia homblei(fr)		X										
Fadogia tetraquetra(fr)	X	X										
Ficus ingens(fr)								X				
Ficus salicifolia(fr)												X
Grewia occidentalis(fl,lv)	X											
Hemizigia transvaalensis(fl)									X	X		
Hemizigia parvifolia(fl)									X	X		
Hypoxis rigidula (st)											X	X
Kotschya parvifolia(fl)						X	X					
Lanea edulis(fr)										X	X	X
Mimisops obovata(fr)								X				
Mundelea serecea(fl)(lv)					X			X			X	
Ochna confusa(fr)											X	X
Ochna natalita (fr)						X						
Olinea emarginata(fr)							X	X				
Olinea rochetiana(fr)	X											

Pachistigma latifolium(fr)	X											
Panicum maximum(sd)	X	X	X								X	
Panicum natalensis(sd)	X		X							X	X	X
Parinari capensis(fr)	X											
Parinari curatellifolia(fr)	X											X
Pearsonia aristata (fl)		X	X									X
Pearsonia sessilifolia(fl)						X					X	
Pearsonia sessilifolia filifolia(fl)									X	X		
Pelargonium dolomiticum(fl)				X								
Peltophorum africanum(pd)			X									
Pterocarpus angolensis(fl)(lv)				X	X					X		
Rhoicussus tridendata(fr)			X									
Rhus pentheri(fr)											X	
Rhus pyroides(fr)										X	X	X
Rhyncosia nitens(fl)		X										
Smilax anceps(fr))				X						X		
Sporobolis pectinatus(rt)					X							
Strychnos spinosa (lv)(fr)												
Syzigium cordatum(fr)	X	X										
Syzigium legatti(fr)		X	X	X	X			X				
Tephrosia longipes(pd)	X	X										
Themeda triandra(lv)				X							X	X
Vanguaria infuasta(fr)	X											
Ziziphus mucronata(fr)			X	X	X							

Annexure B: A complete list of all the plant species collected on the Bourke's Luck section during the study period.

	ACANTHACEAE
7985000-00200	Crossandra greenstockii S.Moore
7978000-00200	Sclerochiton harveyanus Nees
	ADIANTACEAE
0136000-00600	Cheilanthes eckloniana (Kunze) Mett.
0136800-00200	Pellaea calomelanos
	AIZOACEAE
2376000-02700	Limeum viscosum
	ANACARDIACEAE
4563000-00200	Lannea edulis
4594000-00800	Rhus chirindensis Baker f.
4594000-01500	Rhus dentata Thunb.
4594000-05300	Rhus pentheri Zahlbr.
4594000-05570	Rhus pyroides
4594000-07300	Rhus transvaalensis Engl.
	APIACEAE
5922000-00200	Alepidea amatymbica
	ARALIACEAE
5872000-00200	Cussonia natalensis Sond.
5872000-00400	Cussonia paniculata
5872000-00600	Cussonia spicata Thunb.
	ASCLEPIADACEAE
6791000-00100	Asclepias adscendens (Schltr.) Schltr.
6791000-00400	Asclepias aurea (Schltr.) Schltr.
	ASPARAGACEAE
1113000-00350	Asparagus africanus Lam.
1113000-04300	Asparagus virgatus Baker
	ASPHODELACEAE

1026000-00800	Aloe arborescens Mill.
1026000-04100	Aloe dewetii Reynolds
0985010-04750	Trachyandra saltii
	ASTERACEAE
9096000-00500	Anisopappus smutsii Hutch.
9358000-00300	Artemisia afra Jacq. ex Willd.
9055000-00500	Athrixia elata Sond.
9055000-00900	Athrixia phylicoides DC.
9237000-00500	Bidens pilosa L.
8936000-00700	Brachylaena rotundata S.Moore
8936000-00750	Brachylaena transvaalensis E.Phillips & Schweick.
9417000-06900	Euryops pedunculatus N.E.Br.
9090000-00700	Geigeria burkei
9090000-02200	Geigeria otaviensis (Merxm.) Merxm.
9528000-00900	Gerbera jamesonii Bolus ex Adlam
9528000-01250	Gerbera piloselloides (L.) Cass.
9006000-00070	Helichrysum acutatum DC.
9006000-01870	Helichrysum aureonitens Sch.Bip.
9006000-02500	Helichrysum callicomum Harv.
9006000-03600	Helichrysum cooperi Harv.
9006000-08500	Helichrysum kraussii Sch.Bip.
9006000-09700	Helichrysum lepidissimum S.Moore
9006000-12100	Helichrysum nudifolium (L.) Less.
9006000-12700	Helichrysum odoratissimum (L.) Sweet
9006000-13100	Helichrysum oreophilum Klatt
9006000-13250	Helichrysum oxyphyllum DC.
9006000-15900	Helichrysum rugulosum Less.
9006000-16900	Helichrysum setosum Harv.
9006000-17600	Helichrysum splendidum (Thunb.) Less.
9006000-20300	Helichrysum uninervium Burtt Davy
9006000-20800	Helichrysum wilmsii Moeser
9401000-00300	Lopholaena coriifolia (Sond.) E.Phillips & C.A.Sm.
8925000-00200	Nidorella auriculata DC.
9336000-00050	Phymaspermum acerosum (DC.) K„llersj”
9411000-10800	Senecio glaberrimus DC.
9411000-14200	Senecio junodii Hutch. & Burtt Davy
9411000-17000	Senecio microglossus DC.
9411000-18800	Senecio oxyriifolius DC.
9411000-20700	Senecio polyanthemoides Sch.Bip.
9411000-24100	Senecio scitus Hutch. & Burtt Davy
8937000-00100	Tarchonanthus camphoratus L.
8994000-00100	Tenrhynea phylicifolia (DC.) Hilliard & B.L.Burtt
8751000-02400	Vernonia natalensis Sch.Bip. ex Walp.
8751000-03000	Vernonia oligocephala (DC.) Sch.Bip. ex Walp.
8751000-03075	Vernonia poskeana
9155000-00200	Zinnia peruviana (L.) L.

	BIGNONIACEAE
7733000-00050	Tecoma capensis (Thunb.) Lindl.
	CAPANULACEAE
8668000-13100	Wahlenbergia undulata (L.f.) A.DC.
	CAPPRACEAE
3082000-01000	Cleome hirta (Klotzsch) Oliv.
	CELASTRACEAE
4629000-00100	Catha edulis (Vahl) Forssk. ex Endl.
4626000-00400	Maytenus heterophylla (Eckl. & Zeyh.) N.Robson
4626000-00700	Maytenus mossambicensis
4626000-01200	Maytenus peduncularis (Sond.) Loes.
4626000-01800	Maytenus undata (Thunb.) Blakelock
4630000-00100	Pterocelastrus echinatus N.E.Br.
	CHRYSOBALANACEAE
3405000-00100	Parinari capensis
3405000-00200	Parinari curatellifolia Planch. ex Benth.
	CLUSIACEAE
5168000-00100	Hypericum aethiopicum
	COLCHICACEAE
0963000-00100	Gloriosa superba L.
	COMBRETACEAE
5538000-01800	Combretum kraussii Hochst.
5538000-02100	Combretum molle R.Br. ex G.Don
	COMMELINACEAE
0896000-00100	Commelina africana
0896000-00300	Commelina benghalensis L.
0904000-00300	Cyanotis lapidosa E.Phillips
0904000-00500	Cyanotis speciosa (L.f.) Hassk.

	CONNARACEAE
3428000-00200	Cnestis polyphylla Lam.
	CONVOLVULACEAE
7003000-00800	Ipomoea bathycolpos
	CRASSULACEAE
3168000-04900	Crassula capitella
3168000-15950	Crassula lanceolata
3166000-02100	Kalanchoe paniculata Harv.
3166000-02700	Kalanchoe rotundifolia (Haw.) Haw.
	CYPERACEAE
0471010-00400	Bulbostylis burchellii (Ficalho & Hiern) C.B.Clarke
0459000-01900	Cyperus esculentus
0459000-04600	Cyperus obtusiflorus Vahl var. flavissimus (Schrad.) Boeck.
0459000-06370	Cyperus rupestris
0462000-00200	Kyllinga alba Nees
	DENNSTAEDTIACEAE
0153000-00100	Pteridium aquilinum (L.) Kuhn
	EBENACEAE
6406000-01300	Diospyros lycioides
6406000-01600	Diospyros lycioides Desf. ssp. sericea (Bernh.) De Winter
6406000-02900	Diospyros whyteana (Hiern) F.White
6404000-00400	Euclea crispa
6404000-00550	Euclea dewinteri Retief
6404000-00800	Euclea linearis Zeyh. ex Hiern
	ERIOSPERMACEAE
1012000-00100	Eriospermum abyssinicum Baker
1012000-05100	Eriospermum porphyrovalve Baker
	ERYTHROXYLACEAE
3956000-00100	Erythroxylum delagoense Schinz
3956000-00200	Erythroxylum emarginatum Thonn.
	EUPHORBICEAE

4407000-02550	Acalypha villicaulis Hochst. ex A.Rich.
4448000-02300	Clutia monticola S.Moore
4448000-03200	Clutia pulchella
	FABACEAE
3446000-90300	Acacia ataxacantha DC.
3793000-00900	Aeschynomene rehmannii Schinz var. leptobotrya (Harms ex Baker f.) J.B.Gillett
3536010-00500	Chamaecrista comosa E.Mey. var. capricornia (Steyaert) Lock
3669000-01600	Crotalaria doidgeae I.Verd.
3821000-00100	Dalbergia armata E.Mey.
3467000-00200	Elephantorrhiza elephantina (Burch.) Skeels
3702000-13900	Indigofera melanadenia Benth. ex Harv.
3702000-16000	Indigofera oxytropis Benth. ex Harv.
3796010-00100	Kotschya parvifolia (Burtt Davy) Verdc.
3657000-03400	Lotononis eriantha Benth.
3719000-00100	Mundulea sericea (Willd.) A.Chev.
3657010-00100	Pearsonia aristata (Schinz) Dummer
3657010-00850	Pearsonia sessilifolia (Harv.) Dummer ssp. filifolia (Bolus) Polhill
3657010-01000	Pearsonia sessilifolia (Harv.) Dummer ssp. sessilifolia
3561000-00100	Peltophorum africanum Sond.
3808000-00100	Pseudarthria hookeri
3828000-00100	Pterocarpus angolensis DC.
3897000-04400	Rhynchosia monophylla Schltr.
3897000-04700	Rhynchosia nitens Benth.
3718000-04400	Tephrosia longipes
3718000-04420	Tephrosia lupinifolia DC.
3804000-00300	Zornia linearis E.Mey.
	FLACOURTIACEAE
5328000-00700	Dovyalis zeyheri (Sond.) Warb.
5275000-00100	Rawsonia lucida Harv. & Sond.
	GERANIACEAE
3928000-05500	Pelargonium dolomiticum R.Knuth
	HYACINTHACEAE
1090010-01100	Ledebouria ovatifolia (Baker) Jessop
1090010-01200	Ledebouria revoluta (L.f.) Jessop
	HYPOXIDACEAE
1230000-02100	Hypoxis hemerocallidea Fisch. & C.A.Mey.

1230000-02250	Hypoxis iridifolia Baker
1230000-04100	Hypoxis rigidula
	ICACINACEAE
4686000-00100	Apodytes dimidiata
	IRIDACEAE
1295000-02100	Aristea juncifolia Baker
1303000-01400	Dierama medium N.E.Br.
1311000-03300	Gladiolus crassifolius Baker
	LAMIACEAE
7345000-00500	Aeollanthus parvifolius Benth.
7365000-01670	Hemizygia parvifolia Codd
7365000-02700	Hemizygia transvaalensis (Schltr.) M.Ashby
7264000-01610	Leonotis ocymifolia
7339000-00400	Tetradenia riparia (Hochst.) Codd
	LINACEAE
3945000-00400	Linum thunbergii Eckl. & Zeyh.
	LOGANIACEAE
6473000-00100	Buddleja auriculata Benth.
6473000-00700	Buddleja salviifolia (L.) Lam.
6460000-00800	Strychnos spinosa Lam.
	MALPIGHIACEAE
4219000-00450	Sphedamnocarpus pruriens
	MALVACEAE
5013000-01200	Hibiscus calyphyllus Cav.
	MELIACEAE
4193000-00200	Ekebergia pterophylla (C.DC.) Hofmeyr
	MORACEAE
1961000-00050	Ficus abutilifolia (Miq.) Miq.
1961000-01200	Ficus ingens

1961000-02250	Ficus sur Forssk.
1961000-02450	Ficus thonningii Blume
	MYROTHAMNACEAE
3282000-00100	Myrothamnus flabellifolius Welw.
	MYRSINACEAE
6313000-00100	Myrsine africana L.
	MYRTACEAE
5578000-00500	Eugenia natalitia Sond.
5588010-00400	Heteropyxis natalensis Harv.
5583000-00100	Syzygium cordatum Hochst.
5583000-00600	Syzygium legatii Burtt Davy & Greenway
	OCHNACEAE
5112000-00400	Ochna confusa Burtt Davy & Greenway
5112000-00600	Ochna holstii Engl.
5112000-00900	Ochna natalitia (Meisn.) Walp.
	OLACACEAE
2136000-00300	Ximenia caffra
	OLEACEAE
6422000-00100	Schrebera alata (Hochst.) Welw.
	OLINACEAE
5428000-00100	Olinia emarginata Burtt Davy
5428000-00300	Olinia rochetiana Juss.
	OXALIDACEAE
3936000-14800	Oxalis obliquifolia Steud. ex Rich.
	PEDALIACEAE
7778000-00500	Ceratotheca triloba (Bernh.) Hook.f.
	PERIPLOCACEAE

6740000-00200	Cryptolepis oblongifolia (Meisn.) Schltr.
	PINACEAE
0022000-00100	Pinus patula Schltdl. & Cham.
	PITTOSPORACEAE
3252000-00300	Pittosporum viridiflorum Sims
	POACEAE
9900710-00500	Andropogon eucomus Nees
9902620-01900	Aristida junciformis
9903442-00100	Bewsia biflora (Hack.) Gooss.
9901040-01700	Brachiaria serrata (Thunb.) Stapf
9900720-00600	Cymbopogon validus (Stapf) Stapf ex Burtt Davy
9901770-00500	Danthoniopsis pruinosa C.E.Hubb.
9900890-02700	Digitaria monodactyla (Nees) Stapf
9900810-00100	Diheteropogon amplectens (Nees) Clayton
9900280-00100	Elionurus muticus (Spreng.) Kunth
9902860-00100	Eragrostis acraea De Winter
9902860-01500	Eragrostis capensis (Thunb.) Trin.
9902860-02300	Eragrostis curvula (Schrad.) Nees
9902860-03200	Eragrostis gummiflua Nees
9902860-06700	Eragrostis racemosa (Thunb.) Steud.
9902860-08100	Eragrostis superba Peyr.
9900800-00100	Heteropogon contortus (L.) Roem. & Schult.
9900730-00600	Hyparrhenia filipendula
9900731-00100	Hyperthelia dissoluta (Nees ex Steud.) Clayton
9901751-00600	Loudetia simplex (Nees) C.E.Hubb.
9901340-00250	Melinis nerviglumis (Franch.) Zizka
9901340-00275	Melinis repens
9902940-00100	Microchloa caffra Nees
9900750-00100	Monocymbium ceresiiforme (Nees) Stapf
9901160-02800	Panicum maximum Jacq.
9901160-03100	Panicum natalense Hochst.
9901390-00900	Pennisetum natalense Stapf
9902800-00200	Perotis patens Gand.
9903340-00300	Pogonarthria squarrosa (Roem. & Schult.) Pilg.
9901280-01800	Setaria pallide-fusca (Schumach.) Stapf & C.E.Hubb.
9901280-02455	Setaria sphacelata (Schumach.) Moss var. sericea (Stapf) Clayton
9901280-03100	Setaria ustilata de Wit
9902830-02500	Sporobolus pectinatus Hack.
9900830-00100	Themeda triandra Forssk.
9903530-00200	Trichoneura grandiglumis
9901740-00450	Tristachya leucothrix Nees

	POLYGALACEAE
4273000-02900	Polygala hottentotta C.Presl
	PROTEACEAE
2034000-00100	Faurea galpinii E.Phillips
2034000-00300	Faurea saligna Harv.
2035000-03750	Protea laetans L.E.Davidson
	RANUNCULACEAE
2542000-00100	Clematis brachiata Thunb.
	RHAMNACEAE
4875000-00100	Rhamnus prinoides L'H,r.
4861000-00100	Ziziphus mucronata
	RUBIACEAE
8136140-00100	Agathisanthemum bojeri
8352000-00600	Canthium inerme (L.f.) Kuntze
8352000-00800	Canthium mundianum Cham. & Schltdl.
8230000-00100	Cephalanthus natalensis Oliv.
8359010-00050	Fadogia homblei De Wild.
8359010-00150	Fadogia tetraquetra
8285040-00100	Hyperacanthus amoenus (Sims) Bridson
8136200-00700	Oldenlandia herbacea
8359000-00400	Pachystigma latifolium Sond.
8383000-02900	Pavetta lanceolata Eckl.
8383000-03700	Pavetta schumanniana F.Hoffm. ex K.Schum.
8348000-00100	Pentanisia angustifolia (Hochst.) Hochst.
8352030-00400	Psydrax obovata
8285010-00300	Rothmannia globosa (Hochst.) Keay
8308000-00700	Tricalysia lanceolata (Sond.) Burtt Davy
8351000-00400	Vangueria infausta
4043000-00800	Euchaetis linearis Sond.
3991000-00200	Zanthoxylum davyi (I.Verd.) P.G.Waterman
	SANTALACEAE
2118000-16700	Thesium utile A.W.Hill
	SAPOTACEAE
6377020-00100	Englerophytum magalismontanum (Sond.) T.D.Penn.

6386000-00200	Mimusops obovata Sond.
	SCROPHULARIACEAE
7500000-00200	Bowkeria cymosa MacOwan
7560000-00300	Craterostigma wilmsii Engl. ex Diels
7493000-00200	Halleria lucida L.
	SELAGINACEAE
7568040-00400	Tetraselago wilmsii (Rolfe) Hilliard & B.L.Burtt
0113200-00200	Selaginella dregei (C.Presl) Hieron.
	SMILACACEAE
1151000-00050	Smilax anceps Willd.
	SOLANACEAE
7407000-04000	Solanum mauritianum Scop.
7407000-04700	Solanum nigrum L.
7407000-04900	Solanum panduriforme E.Mey.
	STERCULIACEAE
5053000-00500	Dombeya pulchra N.E.Br.
	THYMELAEACEAE
5435000-00320	Gnidia caffra (Meisn.) Gilg
5435000-00340	Gnidia calocephala (C.A.Mey.) Gilg
5435000-06220	Gnidia splendens Meisn.
	TILIACEAE
4966000-01700	Grewia occidentalis L.
4975000-01300	Triumfetta welwitschii
	ULMACEAE
1898000-00100	Celtis africana Burm.f.
1902000-00100	Trema orientalis (L.) Blume
	VELLOZIACEAE
1247010-00400	Xerophyta retinervis Baker

	VERBENACEAE
7144000-00600	Lantana rugosa Thunb.
7145000-00100	Lippia javanica (Burm.f.) Spreng.
7145000-00600	Lippia wilmsii H.Pearson
7138000-00200	Verbena brasiliensis Vell.
	VITACEAE
4918010-01800	Cyphostemma lanigerum (Harv.) Desc. ex Wild & R.B.Drumm.
4917000-00550	Rhoicissus tridentata

Table 4.1 Phytosociological table of the Bourke's Luck Section of the BCNR

Community number	1		2																										3							4																5			6				7	
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			2.1.1			2.1.2							2.3.1					2.3.2																																										
Releve numbers	47	48	17	18	19	43	44	51	60	21	22	45	8	1	2	3	9	15	16	29	34	42	10	12	13	4	53	5	6	7	14	23	24	36	46	56	27	28	30	31	32	33	35	37	38	39	40	41	49	50	11	55	20	25	26	54	58	57	52	59	61
Species Group A																																																													
Heteropogon contortus	a	a	.	.	.	.	.	1	.	.	.	.	1	.	.	.	3	.	.	.	+	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
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Verbena brasiliensis	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum callicomum	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group B																																																													
Diheteropogon amplectens	+	1	1	+	1	a	1	a	+	1	1	.	.	1	+	+	3	+	1	+	+	+	.	r	.	+	.	.	.	.	.	+	+	.	.	.	+	.	1	+	.	+	.	+	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Bulbostylis burchellii	.	.	+	1	.	.	+	+	.	1	.	1	r	1	1	1	r	r	+	+	r	r	.	r	r	1	+	.	.	.	r	.	+	.	.	.	.	.	r	+	.	.	r	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Aristida junciformis	.	.	r	1	+	+	+	r	.	.	.	+	r	1	r	+	r	+	+	.	r	+	.	1	1	+	+	.	.	.	r	.	+	.	r	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.
Hemizygia transvaalens	.	.	a	1	1	1	1	1	1	+	1	a	.	.	r	.	r	+	1	.	r	.	r	.	.	.	.	+	.	.	+	.	.	+	1	.	.	+	.	.	.	.	+	+	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Lannea edulis	.	.	1	.	+	.	+	+	+	.	.	.	.	1	.	1	r	.	.	1	a	+	r	.	.	1	+	1	1	+	.	.	.	.	.	+	.	r	+	.	.	.	.	.	r	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.
Vernonia natalensis	.	.	.	.	r	r	+	.	+	.	+	.	.	+	+	r	.	+	.	.	.	r	.	.	.	.	.	.	.	.	r	.	.	.	r	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r
Phymaspermum acerosum	.	.	1	+	.	r	1	.	1	+	1	+	.	+	.	.	.	r	1	.	+	.	.	.	1	+	r	1	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio scitus	r	.	.	.	.	r	r	+	r	.	+	.	+	.	.	.	.	.	r	r	.	r	1	.	.	+	.	r	r	+	.	r	r	.	1	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group C																																																													
Themeda triandra	.	1	a	+	a	.	.	.	1	+	1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
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Agathisanthemum bojeri	.	.	.	+	+	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.
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Crassula lanceolata	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum oxyphyllum	.	.	a	r	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tephrosia lupinifolia	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Nidorella auriculata	.	.	r	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group D																																																													
Hyparrhenia filipendulla	a	1	+	+	+	.	.	.	.	1	1	.	.	.	.	1	r	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	r	.
Helichrysum nudifolium	r	1	r	.	3	+	.	+	.	.	.	.	r	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio junodii	1	r	+	r	+	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.
Geigeria burkei	.	r	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group E																																																													
Athrixia phylicoides	.	.	+	+	r	+	r	+	.	.	.	.	+	.	.	.	1	+	.	r	.	.	.	.	.	.	r	.	.	.	r	.	.	.	.	.	.	+	.	.	r	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.
Triumfetta welwitschii	.	.	r	r	1	r	r	r	.	.	.	r	1	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helichrysum cooperi	.	.	+	a	+	.	1	.	.	3	.	+	.	.	.	.	r	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Monocymbium ceresiiforme	.	.	1	1	+	+	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eragrostis capensis	.	.	+	.	+	.	.	1	.	.	1	1	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.
Lotononis eriantha	.	.	.	r	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Species Group F																																																													
Panicum natalense	.	.	1	.	.	.	.	1	.	a	.	3	.	+	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.
Helichrysum wilmsii	.	.	.	.	.	.	.	.	.	.	a	b	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	+	.	.	.	.	.	.	.
Senecio microglossus	.	.	.	.	.	.	.	.	.	1	1	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Oxalis obliquifolia	.	.	.	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Athrixia elata	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus obtusifolius	.	.	.	.	.	.	.	.	.	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Species Group G

Brachiaria serrata	. .	. . .	1 + . .	. . .	+ + + 1 r	+ + + a 1 r .	. . . . .	. . . .	+ . . . . . + + ... 1 r .	. . .	. .	. .	. .
Selaginella dregei	. .	. . .	. . . .	. . .	. 1 . . r	. . a . . . 3	. . 1 . .	. . . . . + .	. . + 1 . . + ... +	. . .	. .	. .	. .
Hypoxis iridifolia	. .	. r .	. . . .	. . .	+ . r . 1	. r . . . 1 1	. . . . .	. + ...	. . . . . . r	. . .	. .	. .	. .
Kyllinga alba	. .	. 1 .	. . . .	. . .	. + . . 1	. . . r . . .	. + . . .	. . . .	. . . . r . . . . . +	. . .	. .	. .	. .

Species Group H

Diospyros lycioides	. .	. . .	. . . .	. . .	1 + . . r	+ 1	. . . . .	. . . .	. . . .	. . .	. .	. .	. .
Eragrostis gummiflua	. .	. . .	. . . .	. . .	1 1 1 . 3	. . + ...	. . 1 . .	. . . .	. . . . + ... +	. . .	. .	. .	. .
Wahlenbergia undulata	. .	r . .	. . . .	+ . .	r + . . 1	. . . .	. . . . r	. . . . . r .	. . . . r	. . .	. .	. .	. .
Eragrostis racemosa	. +	+ . .	1 + . +	. . .	+ 1 . a r	r . 1 1 . . .	. . . . .	. . . .	. . . . + ...	. . .	. .	. .	+ .
Commelina benghalensis	. .	. . +	. . . .	. . .	1 + + . .	. + . . . 1 .	1	. . . .	+ . . . . + . + ...	. . .	. .	. .	. .
Digitaria monodactyla	. .	. . .	. . . .	+ . .	. + . 1 r	+ + . + . . .	. . . . .	. . . .	. . . .	. . .	. .	. .	. .
Gladiolus crassifolius	. .	. . r	. . . r	. r r	. r r 1 .	. . . r . 1 .	. . . . .	. . . .	. . . .	. r .	. .	. .	. .
Pearsonia sessilifolia	. .	a . .	. . . .	. . .	. + a a .	. . . .	. . . . .	. . . .	. . . .	. . .	. .	. .	. .
Trachyandra saltii	. .	. . .	. . . .	. . .	r . r . 1	. . . .	. . r . .	. . . .	. . . .	. . .	. .	. .	. .
Ipomoea bathycolpos	. .	. . .	. . . .	. . .	. r . . 1	. . . . . 1 .	. . . . .	. . . .	. . . . r . . .	. . .	. .	. .	. .
Melinis nerviglumis	. .	. . .	. . . r	. . +	a + . + 3	. + ...	. . . . .	+ . . . . + .	. . . . + ...	. . 1	. .	. .	r .

Species Group I

Gnidia splendens	. .	. . .	r . . .	. r .	 1	+ + r . r 1 3	. . . . .	. r	. . r r . . r 1	. . r	. .	. .	. .
Zornia linearis	. .	. . +	1 r . r	. . .	. . . . .	+ 1 . . r 1 .	. . . . .	. + ...	. . . .	. . .	. .	. .	. .
Elionurus muticus	. .	. . .	a + + .	. + .	. . . r .	1 + + b . r r	. + . . .	. + ...	r	. . .	. .	. .	. .
Myrothamnus flabellifolius	. .	. . .	. . . .	. . .	. . . . .	. . + . . . 1	. . . . .	. . . . . r .	. . . .	. . .	. .	. .	. .
Microchloa caffra	. .	. . .	. . . .	. . .	. . . . .	. . a 1 . . .	. . . . .	. . . .	. . r . . . . +	. . .	. .	. .	. .

Species Group J

Elephantorrhiza elephantina	. .	. + .	. . . .	. . .	. . . . .	. . . .	. a . 1 .	. . . .	. . . .	. . .	. .	. .	. .
Aloe dewetii	. .	. . .	. . . .	. . .	r	. . . .	. r . r +	. . . .	. . . .	. . .	. .	. .	. .
Ximenia caffra	. .	. . .	. . . .	. . .	. . . . .	. . . .	1 . . r .	r	. . . .	. . r	. .	. .	. .
Crassula capitella	. .	. . .	. . . .	. . .	. . . . .	. . . .	. r . . r	. . . .	. . . .	. . .	. .	. .	. .

Species Group K

Tetraselago wilmsii	. .	r . .	+ . . .	. . .	+ 1 1 . .	. + ...	. + r . .	1 r 1 1 + 1 .	. . . .	r 1 +	. .	. .	r .
Pellaea calomelanos	. .	. . .	. . . .	. . .	 1	. . . .	1 r . . .	. r r r r r .	. . . r . r . . r . r r r . . r	r . .	. .	. .	. .
Helichrysum uninervium	. .	. . .	r r . .	. . .	. . . r 1	. r . r r 1 .	. . . . .	. r r r r r .	r . r r r . r . . . . 1 .	. . .	. .	. .	. .
Smilax anceps	. .	. . .	. . . .	. . .	 1	. . . .	. . . . .	r . + . a + .	. . . . . + + . 1 1 + + . . 1 .	. + .	. .	. .	. .
Pteridium aquilinum	. .	. . .	. . . .	. . .	. . . . .	. 1	. . . . .	. + 1 . 3 + .	. . . .	+ 1 .	. +	. .	. .
Kotschya parvifolia	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . 1 . .	. . 3 3 . + +	. . . . r	. . .	. .	. .	. .

Species Group L

Anisopappus smutsii	. .	. . .	. . . .	. . .	. . . . .	. . . .	1 . . . +	r	. . r r . . . 3 r . . 1 + . . r	. . .	. .	. .	. .
Asparagus virgatus	. .	. . .	. . . .	. . .	. . . . .	. r	. . . . +	. + ...	r r r r r r r	. . .	. .	. .	. .
Pavetta schumanniana	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	+ + ...	+ . . + + 1 + . r . . + + . r .	. . .	. .	. .	. .
Cyperus esculentus	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . . r . +	. . . . + r r . . + r 1 r	. . .	. .	. .	. .
Syzygium legatii	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . + ...	. . r r 1 + a . 1 . 1	. . .	. .	. .	. .
Danthoniopsis pruinosa	. .	. . .	. . . .	. . .	. r + . 3	. . . . r . .	. . . 1 a	. . . .	+ 1 . . . 1 . 1 1 . 1 + a a r +	. . .	. +	. .	. .
Pterocarpus angolensis	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. 3 3 1 . + 1 3 . . . b 4 5 . .	3 . .	. 1	. .	. .
Ochna confusa	. .	. . .	. . . .	. . .	. . . . .	. . . r . . .	. . . . .	r + ... r	r r . . . + . . + . + . . r . .	. . .	. r	r .	. .
Syzygium cordatum	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . . a 1 .	. . . + . r 1 . 1	. . .	. .	1 .	. .
Tetradenia riparia	. .	. . .	. . . .	. . r	r	. . . .	. . . + .	. . r . . . +	. . r . r . . . . . + . + r 1 .	. . .	. +	. .	. .
Combretum molle	. .	. . .	. . . .	. . .	. . . . .	. . r . 1 . .	. . . . .	. . . . + . .	r r . . 1 1 + a r + . 1 1 1 . .	. . 1	. 1	1 .	. .
Pterocelastr echinatus	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . + . . .	. r . . + + . . . r 1 + ...	. . .	1 .	1 .	. .
Aeollanthus parvifoliu	. .	. . .	. . . .	. . .	. . . . .	. . r	. . . . r	r . . . . . r	. . . r . + ... r . . r r	. . .	. .	. .	. .
Rhoicissus tridentata	. .	. . .	. . . .	. . .	r	. . . .	. . . r .	. . . .	. r . . . . r . . 1	. . .	r .	. .	. .
Ekebergia pterophylla	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . + ...	. . . r b . . . . . . 1 1 . 1 .	. . .	1 .	. .	. .
Brachylaena transvaale	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . . 1 . . . 1 + . .	. . .	. 1	. .	. .
Parinari curatellifol	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	+	r . . 1 1	. . .	. .	. .	. .
Strychnos spinosa	. .	. . .	. . . .	. . .	. . . . r	. . . .	. . . . .	. . . .	. r r 1	. . .	. .	. .	. .
Cussonia natalensis	. .	. . .	. . . .	. . .	. . . . .	. . . . r . .	. . . . .	. . . . . r .	. . . . r . 1 . 1 . . . 1	. . .	. .	. .	. .
Heteropyxis natalensis	. .	+ . .	. . . .	. . .	r	. . . .	. . . . .	. . . . . + .	. . . r + ... + + . r .	+ . .	1 +	1 .	. .
Helichrysum odoratissi	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . . + r + . + ...	. . .	. .	. .	. .

Spcies Group M													
Loudetia simplex	. .	+ + +	1 1 1 a	1 1 .	a a a + 3	1 1 + + + r r	r 1 1 + .	1 . 1 + + + .	1 + 3 + + + . + + + + + 1 . . .	. . .	. .	. .	r .
Helichrysum kraussii	. .	+ 1 .	. . 1 r	b a .	+ . + . r	+ . + . + . 3	r . 1 . .	1 1 a 1 1 1 1	r 1 b 1 + 1 + 1 a 1 1 + + . r 1	. . .	. .	. .	. .
Sporobolus pectinatus	. .	a + +	1 r . +	1 . .	1 1 1 a r	+ 1 r 1 1 r r	1 1 r . .	. + 1 + . 1 +	1 . 1 1 . + 1	. . .	. .	. .	1 .
Crotalaria doidgeae	1 +	a . +	. 1 . +	. + .	+ . . . 3	. 1 . r . r .	. . . + +	+ . . . 1 . +	. . . . + r . + . 1 + . . . 1 .	+ . .	. .	. .	. +
Commelina africana	. .	1 1 +	r . . .	+ + +	1 + 1 . .	. r	. . . . r	. . . + + . .	. . . r + r . + . + r 1 . . . r	+ 1 .	. .	. .	. .
Acalypha villicaulis	. .	. 1 +	+ r . r	. . 1	r . . . 1	r + . . . r .	. . . . r	. r . . r . .	+ . . . . . r r r r . r r . 1 .	. . .	. .	. .	. .
Indigofera oxytropis	. .	+ . r	r . . .	. + .	 1	. + . . . 1 .	. . . . .	. . . . r . r	. . . . . r . . r . r	. . .	. .	. .	. .
Pentanisia angustifolia	. .	r . .	. . . +	. . +	. + + + .	. . r	. . . . .	. . . r . + r	. . r . . . . r r	. . .	. .	. .	r +
Cyperus rupestris	. .	r 1 .	. . . .	. . .	. + . . 1	. r a . . . 1	1 . r + .	. . . .	. r r . r . . . . . . r	. . r	. .	. .	. .
Species Group N													
Aeschynomene rehmannii	. .	. . .	. . r .	1 1 1	+ r . 1 1	+ + r + + r 3	3 1 . . r	r + . + . . +	1 + r r . + + . r + r r + . . 1	r . +	. .	. .	. .
Rhus pyroides	r .	. . .	r 1 + r	. r r	+ + . . r	r + . r . r .	. . r . .	1 + + + r r +	+ r r . r + + r r . + . . . r .	r + .	. .	. .	. .
Parinari capensis	. .	. . .	. . + 1	. . .	. + 1 b .	1 1 + . . 3 r	. . . + .	. . . .	b . . . . + ...	. . .	. .	. .	. .
Fadogia tetraquetra	. .	1 . .	. . . +	+ + .	1 1 b a .	1 1 r + 1 3 3	1 1 . 1 .	+ 1 1 1 1 1 .	b + 1 1 + . + + r + . + + + 1 .	+ a 1	. .	. .	r .
Cheilanthes eckloniana	. .	. + r	. + r .	r . .	+ r 1 + r	. . r . + . 1	1 1 r + +	r . + r . + +	+ + + r r r . + . + r r + r r 1	r . +	. .	. .	. .
Pearsonia sessilifolia	. .	. . .	3 4 a 1	1 + .	a . . . 3	1 a + + a r r	1 a 1 a 1	r 1 1 + . 1 +	+ . 1 + + . + ... + 1 .	+ + 1	. .	. .	. .
Spcies Group O													
Senecio glaberrimus	. .	. . .	1 . . +	. 1 .	+ + 1 1 r	+ + . 1 + . .	1 a + 1 1	+ r 1 1 . . .	. . . . + + + + + . . . r + r .	r . .	. .	. .	. .
Rhynchosia monophylla	. .	. r r	. . . .	. . .	. r . 1 r	+ + r . + 1 r	r 1 r 1 .	. + . . . + +	1 r . r r . + . + . . . r r . +	r . .	. .	. .	. .
Pachystigma latifolium	. .	+ + .	. . . +	. . .	1 + . + r	. 1 . r . . .	1 r r + .	. + . . r . .	. + . + + . . . r + . + r + . .	+ . .	. .	. .	. .
Setaria pallide-fusca	. .	. . .	. . . r	. . .	+ . . . 3	. + . 1 r 3 r	. + . + .	. + ...	r 1 r r + + ... + + . . r .	1 . .	. .	. .	. r
Hypoxis rigidula	. .	. r r	. . . .	. . .	r r + 1 .	r . r . + 1 .	. 1 . + 1	+ + . r + . .	. . . . r + r + ...	. . .	. .	. .	. .
Tephrosia longipes	. .	. . .	. . . r	. . .	. . . + 1	. r . r + 1 1	. + . . .	. r . . . + .	+ + r + . . + ... + + + 1 .	+ . .	. .	. .	. .
Vernonia poskeana	. .	. . .	. . . r	. . .	+ . + . 1	. . . . + . 1	r . r . .	r . . + . . r	r . + + . . r . r r . r . . . r	+ . .	. .	. .	r .
Cyanotis speciosa	. .	r . .	r r . .	. . .	. + 1 1 .	r r . . . 1 .	1 1 . . .	. r . . r . r	. . . . . . r r . . . . + r . r	. . .	. .	. .	. .
Eragrostis acraea	. .	. . .	. . r .	. . .	. 1 + . r	 1	1 . + . .	 1	r . 1 . . . . r 1	. . .	. .	. .	. .
Selaginella dregei	. .	. . .	. . . .	. . .	. 1 . . r	. . a . . . 3	. . 1 . .	. . . . . + .	. . + 1 . . + ... +	. . .	. .	. .	. .
Mundulea sericea	. .	. . .	. . . .	. . .	r	+	. + . . .	. + ...	. . + + . . + 1 . + . . + . r .	. . .	. .	. .	. .
Hemizygia parvifolia	. .	. . .	. . . .	. . .	. . + . r	+ . . . . r .	. + . . .	. r	. . . . r . . . . . 1 . . . 3 .	+ . .	. .	. .	. .
Species Group P													
Lopholaena coriifolia	. .	. . .	. . . .	. . .	. . . . .	. . r r r . 3	1 + . a 1	r . 1 1 . 1 .	+ . 1 + r r r . . + r r + . 1 1	. . .	. .	. .	. .
Faurea saligna	. .	. . .	. . . .	. . .	. r . . .	3 1 . . + r .	. + + 1 .	+ a 1 1 + . .	1 + . . + 1 . . + . + . + . . .	1 3 1	. +	. .	. .
Englerophytum magalismontanum	. .	. . .	. . . .	. . .	. . . + r	. . . . 1 1 r	3 + + 1 +	1 1 + a 1 1 1	+ 1 b a 3 a 1 1 a 1 1 1 a 3 r a	+ 1 .	1 b	3 .	. .
Cryptolepis oblongifolia	. .	. . .	. . . r	. . .	. . . + .	. . r + 1 r .	1 1 . + +	r . . r . r .	r + 1 1 + + ... + + r . .	. 1 .	. .	. .	. .
Euclea linearis	. .	. . .	. . . .	. . .	+ . . + r	1 a + r 1 3 3	r 1 . . .	b b . . a . .	+ + 1 1 1 3 1 + + 1 + + + . r +	. . +	. +	. .	. .
Indigofera melanadenia	. .	. . .	. . . .	. . a	. . . r .	. . + . + 1 r	1 . r . .	b . . . 1 r +	r r + + + . . + . . + + + r r 1	. . .	. .	. .	. .
Senecio oxyriifolius	. .	. . .	. . . .	. . r	r	r . . . r 1 .	. . . . .	. . . .	r r . r r . + . . . r + r . r r	. . .	. .	. .	. .
Tristachya leucothrix	. .	. . .	. . + .	. . .	1	1 1 . . + . .	. . . a .	1 1 1 . 1 1 +	1 3 a 3 3 1 1 + 1 . + a a a . a	1 . .	. .	. .	. .
Pearsonia aristata	. .	. . .	. . . .	. . .	. . . . .	. . . r . r .	1	. . r	r . . r + . + ...	. . .	. .	. .	. .
Panicum maximum	. .	. . .	. . . .	. + .	. . . . .	. . . .	. . . + .	. 1 . + . . .	. . . . 1 . . . . r .	. . .	. .	. 1	. .
Vangueria infausta	. .	. . .	. . . .	. . .	. . . . .	. . . r . . .	1 + r 1 1	. . r . r . +	+ r . + + + 1 r r 1 . + + . r +	1 . .	1 .	+ .	. .
Species Group Q													
Rhynchosia nitens	. .	. . .	. . . .	. . .	. . . . .	. . . .	. a . + r	+ + ...	+ . . . r 1 . . . r r	+ 1 +	. .	. .	. .
Cymbopogon validus	. .	. . .	. . . .	. . .	a . . . 3	. . . .	. . . . .	a + ...	. . . . 1 1 .	b 1 3	. .	. .	. .
Euclea dewinteri	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . . . r .	. . . .	+ + +	. .	. .	. .
Polygala hottentotta	. .	. r .	. . . .	. . .	 1	 1	. . . . .	. . + r . + .	r r . r . r . . . . . r r . r .	+ + .	. .	. .	. .
Tricalysia lanceolata	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. r 3	r .	+ .	. .
Rhus dentata	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . . r 1	. 1 1	r .	+ +	. .
Rhus transvaalensis	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. + +	. .	. .	. .

Species Group R													
Acacia ataxacantha	. .	. . .	. . . .	. . .	1	. . . .	. . . . .	. . . r . . .	. . . . + ... r . 1	. . 1	1 b	b a	. .
Diospyros whyteana	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . + . .	. . . .	. . . .	. . .	1 .	r 1	. .
Combretum kraussii	. .	. . .	. . . .	. . .	. . . . .	. . r	1	. . . .	. . . . 3 .	. . .	a 1	a 1	. .
Rhamnus prinoides	. .	. . .	. . . .	. . .	1	. . . .	. . . . .	. . . .	. . . . 1 . . . r . .	. . .	1 .	1 1	. .
Maytenus undata	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	r .	r r	. .
Maytenus mossambicens	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	r r	+ r	. .
Ficus ingens	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	1 1	1 .	. .
Tarchonanthu camphoratus	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	+ r	+ .	. .
Ziziphus mucronata	. .	. . .	. . . r	. r .	+	. . . .	. . . . .	. . . .	. . . . a	. . 1	b .	1 a	. .
Dalbergia armata	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . . . r	. . .	+ r	+ r	. .
Erythroxylum delagoens	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	r .	r .	. .
Bowkeria cymosa	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. +	. r	. .
Ochna holstii	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	r .	+ .	. .
Euclea crispa	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. +	r .	. .
Species Group S													
Canthium mundianum	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	r 1	. . . . 3 .	. . .	1 +	. .	. .
Peltophorum africanum	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	1	+ r . . + ...	. . .	. a	. .	. .
Olinia emarginata	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	a .	. .	. .
Species Group T													
Clematis brachiata	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. r	r r	. .
Clutia pulchella	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. .	r r	. .
Cnestis polyphylla	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. .	r r	. .
Ficus thonningii	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. .	+ +	. .
Halleria lucida	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. r	+ 1	. .
Pittosporum viridiflora	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. .	+ +	. .
Rawsonia lucida	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	+ .	+ r	. .
Mimusops obovata	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . + ... r r + ...	. . .	. 1	+ .	. .
Canthium inerme	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . r r . . . . r . . +	. . .	. r	. 1	. .
Rothmannia globosa	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. .	+ +	. .
Grewia occidentalis	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . r .	. . . .	. . . .	. . .	. .	. +	. .
Sclerochiton harveyanus	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. .	r r	. .
Trema orientalis	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. .	r r	. .
Species Group U													
Pinus patula	. .	. . .	. . . .	. . .	. . . . .	. . . .	. . . . .	. . . .	. . . .	. . .	. .	. .	b 5
Species Group V													
Melinis repens	1 .	+ . .	1 . . +	1 1 .	. . . . .	. + . 1 . . r	r . + 1 1	. . . + . . +	. . . . . . + 1 + ... +	. . .	. .	. .	r .