The relevance of ecosystems to ecotourism in the Waterberg Biosphere Reserve

by

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Promotor: Prof. Dr. G. J. Bredenkamp

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ABSTRACT

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The Waterberg area, Limpopo Province, South Africa, is still one of the unexplored areas of South Africa. It holds great potential as an ecotourist destination, especially considering the many nature reserves and game farms within the area. The promotion of these ecotourist destinations within the area can therefore not be underestimated. The newly declared Waterberg Biosphere Reserve (previously known as the Waterberg Nature Conservancy) stretches over an area of 150 000 hectares and have many conservation areas preserving a high diversity of natural resources. The Biosphere Reserve plays an important role in conservation and sustainable development and currently, other research projects are undertaken involving these aspects. This study was performed to identify different aspects of ecosystems (e. g. physical conditions, plant communities, landscapes, mammal and bird habitats) which can enhance the potential of ecotourism within the relatively unknown area.

Twelve major plant communities were identified within the Biosphere Reserve. The data, from which the analysis was done, were obtained from previous phytosociological studies and additional field surveys were performed in unexplored areas. The major plant communities formed the basis from which other analyses were performed, emphasizing the value of vegetation science in environmental planning and analysis. Tree and shrub species were analyzed as ecotourist attractions within the plant communities according to specific attributes they possess (e. g. medicinal properties, flowers, food source). Six ecozones were identified as a mosaic of

different plant communities within a homogenous landscape, and it is suggested that they should be incorporated as ecological management units as part of an ecological management plan of the Biosphere Reserve. These ecozones each include specific mammal (5 types) or bird (7 types) habitat types, providing the living conditions preferred by the specific species. The major plant communities provided the basis for the identification of these habitat types. The importance to conserve these habitats, especially of species on the red data listed, threatened species, and the importance of monitoring projects are emphasized in the study.

The plant communities were also identified for their specific value to the ecotourism industry. The vegetation structure and species composition of plant communities will often determine which mammal or bird species can be viewed by tourists while participating in activities such as game drives in the habitat types.

A tourism booklet providing tourists with information on the tourist attractions and ecotourist destinations within the Biosphere Reserve is planned, to promote the area as a tourist destination in the future. The study also provides the basis for many possible research projects in the ecological and ecotourism fields in the future.

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CHAPTER 1
INTRODUCTION

1.1 Motivation for Study

The Waterberg Area, Limpopo Province, is a relatively unknown destination to many people and has been described as South Africa's best-kept secret. The rugged beauty of the area, together with it's diversity in plant and animal life, has led to the development of several exciting ecotourism destinations, such as the Marakele National Park, Lapalala Wilderness, Entabeni Game Reserve and many more [Northern Province Tourism Board (NPTB), 1999]. Perhaps no other activity has grown over the past decades with the same speed and global dispersal as tourism. The various types of tourism that have arisen over the past few decades, including ecotourism, nature-based-, alternative- and small-scale tourism are indicative of this higher level of awareness (Godde *et al.* 2000). Considering the huge increase in the amount of international tourists visiting South Africa since 1994 (Figure 1.1), the development of ecotourist destinations within the malaria-free Waterberg area might prove to be economically beneficial to reserve owners and managers. In fact, many cattle farmers in the area are converting to game ranching activities and they earn foreign currency mostly through ecotourism and trophy hunting (Van der Waal & Dekker, 2000).

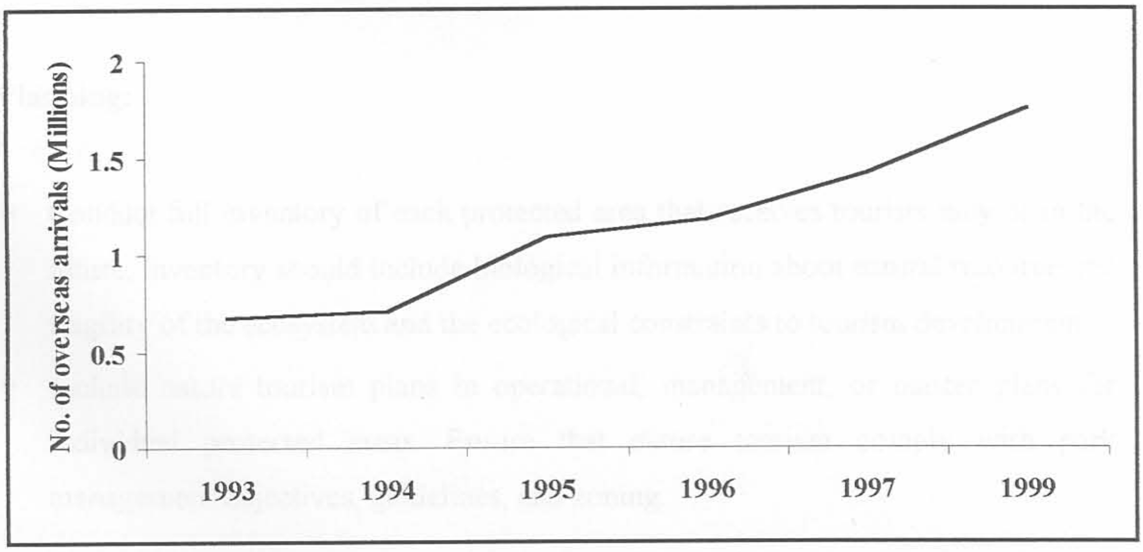

Figure 1.1 International Tourist Arrivals to South Africa from 1994 to 1999.

The Waterberg Nature Conservancy was formed in 1982. The Conservancy comprising private landowners from a variety of backgrounds and nationalities, carried out a variety of activities that are important to landowners, such as security, fire protection, improvement of staff housing, better wages, wildlife related matters, alien plant eradication, representation to the Government and community outreach programs (Walker, 2000). On the 23rd of March 2001, this 150 000 ha area was proclaimed a biosphere reserve according to UNESCO's Man and the Biosphere Program (UNESCO, 1971).

The newly proclaimed reserve is still in a relatively growing phase and the importance for ecotourist destinations in the Biosphere Reserve to have a proper ecological and tourism management plan in place cannot be underestimated. Boo (1991) states that a comprehensive framework for planning ecotourism needs to be put in place on ecotourist destinations, to both maximize the potential benefits and minimize the potential costs for people and the environment. Therefore, some recommendations need to be formulated and shared with reserve managers of ecotourist destinations on how tourist activities could be promoted to realize the full potential of tourism within the Waterberg Biosphere Reserve. Several of these recommendations were made to people involved, e. g. ministries, tour operators, local conservation organizations and international development and conservation organizations. Some recommendations of relevance to reserve and park managers include the following as stated by Boo (1991):

Planning:

- Conduct full inventory of each protected area that receives tourists now or in the future. Inventory should include biological information about natural resource, the fragility of the ecosystem and the ecological constraints to tourism development
- Include nature tourism plans in operational, management, or master plans for individual protected areas. Ensure that nature tourism comply with park management objectives, guidelines, and zoning.

Development

- Create effective trial systems and interpretive programs for parks and reserves
- Provide necessary training for park personnel
- Collect baseline data on natural and cultural resources before and during promotion of tourism
- Conduct environmental impact studies and establish tolerable levels of visitation
- Develop guidelines for tourists to follow while in the park.

Management

- Evaluate the effectiveness of interpretative materials and adjust them if necessary
- Monitor guide training programs to make sure they are keeping up with tourist demand.

This study form the basis in providing guidelines to reserve managers, guides and tourists for most of the above-mentioned recommendations, especially through tourist activities like game drives, nature trials and bird watching safaris. Preston & Fuggle (1988) have already shown how tourists visiting nature areas have a committed interest in nature, and took advantage of interpretive facilities and programs available. The study could therefore provide the basis for tourism promotion in the Waterberg Biosphere Reserve over the long term.

Bredenkamp & Brown (2001) emphasized the study of plant communities, as fundamental units of ecosystems, and therefore being the basis for environmental planning and management plans. Information on vegetation may be required to solve an ecological problem: for biological conservation and management purposes; as an input to environmental impact statements; to monitor management practices or to provide the basis for prediction of possible future changes (Kent & Coker, 1996). Despite the wealth of phytosociological research conducted on smaller properties and reserves within the Waterberg Biosphere Reserve (Westfall, 1981; Furniss, 1998; Newberry, 1998; Van Staden, in prep.), no attempt has ever been made to synthesize existing knowledge of vegetation by means of a phytosociological classification of the area. The procedure will produce identification of the major plant communities within the Waterberg Biosphere Reserve. This could provide the basis for a broad-scale environmental management plan for the Biosphere Reserve.

Gertenbach (1983) and Van Staden (in prep.) identified landscapes as management units within large national parks and conservation areas. Gertenbach (1983) defined a landscape as an area with a recurrent pattern of plant communities with their associated fauna and specific geomorphology, climate, soil and vegetation pattern. These landscapes were classified as ecozones in a tourism booklet of the Kruger National Park (Jacana, 1997), which provide tourists with useful information regarding trees, birds and mammals to be seen in certain habitats with certain characteristics (e. g. soil, geology, climate). The identification and possible presentation of similar ecozones and other useful information on the mammals, birds and trees of the Waterberg Biosphere Reserve will provide tourists with useful and interesting facts on the ecosystems within the Biosphere Reserve and might greatly enhance their experience. It will also increase the awareness of tourists towards sensitive ecosystems, especially regarding rare plant-, mammal- and bird species, and thereby contribute to fullfil conservation management practices to maintain sensitive ecosystems in their pristine condition.

1.2 Objectives of study

The primary objective of this study is to identify the major plant communities as ecosystems of the Waterberg Biosphere Reserve, and to emphasize the importance of vegetation ecology as a tool for the planning and promotion of tourist activities on ecotourist destinations within the Waterberg Biosphere Reserve.

The secondary objectives of this project are to:

- Identify the main ecozones (homogenous landscapes) within the Waterberg Biosphere Reserve and indicate the plant communities as fundamental units within the ecozone on a catena (landscape section drawing)

- Create an ecozone map of the Waterberg Biosphere Reserve as basis for an environmental management plan
- Indicate the potential of each plant community for the main tourist attractions in the Waterberg Biosphere Reserve (game viewing, bird-watching and tree identification)
- Identify future research projects concerning tourism and vegetation impacts

1.3 Scope and Structuring of dissertation

As stated earlier very little vegetation research has been carried out on large areas in the Savanna Biome, southern Africa. The many local, individual phytosociological studies conducted in the Waterberg area, Limpopo Province, provided sufficient data for an overview classification of the major plant communities of the Waterberg Biosphere Reserve, similar to the studies conducted by Winterbach (1998) and Du Plessis (2000). The main theme throughout the dissertation remained the use of different aspects of vegetation ecology as a tool for promoting ecotourism within the Biosphere Reserve, and not to compile a formal syntaxonomy of the vegetation.

Chapter 2 provides a review of different aspects of tourism, conservation, natural resource management, sustainable development, southern African savannas and biosphere reserves. All these aspects are interlinked in a way by the fact that biosphere reserves play an integral part in sustainable development, conservation, ecotourism and natural resource management (Walker, 2000). Considering the fact that the Waterberg Biosphere Reserve is situated in one of the most remote areas of the Savanna biome of southern Africa, the importance of such a conservation area, where humans and nature still co-exist in harmony, cannot be underestimated. The area and its environmental characteristics such as geology, soils, climate, geomorphology and broad vegetation patterns are described within Chapter 3.

The classification of the major plant communities is presented in Chapter 4 and includes a description of the correlating environmental factors. Plant communities form specific vegetation patterns in a landscape with specific geomorphology, geology, soils and climate (Gertenbach, 1983). These patterns are identified as functional management units, namely ecozones. Each ecozone represents an aesthetic valuable area of the Waterberg Biosphere Reserve, and possibly also to the tourism industry. Mountainous areas are desired destinations for many tourists worldwide, offering a place of rest, solitude, adventure, recreation and scenic beauty (Godde *et al.* 2000). However, the value of certain natural resources forming the main theme of ecotourist activities on ecotourist destinations is realised in Chapters 6, 7 and 8. Chapter 6 includes a description of the different trees and shrubs occurring in the plant communities and the value they represent to the tourism industry through their many interesting characteristics (medicinal properties, food source, uses and flowering display). Chapter 7 includes a classification of the major habitat types of the larger mammals occurring on the many game reserves in the Waterberg Biosphere Reserve. The habitat types are represented as combined plant communities (Chapter 4) and the possible values these habitat types may have for game viewing and other tourist activities are discussed. The same principle is used in Chapter 8 where specific birds that occur within the Biosphere reserve were selected and classified by their habitat preferences.

The scope and structuring of the dissertation is presented in figure 1.2

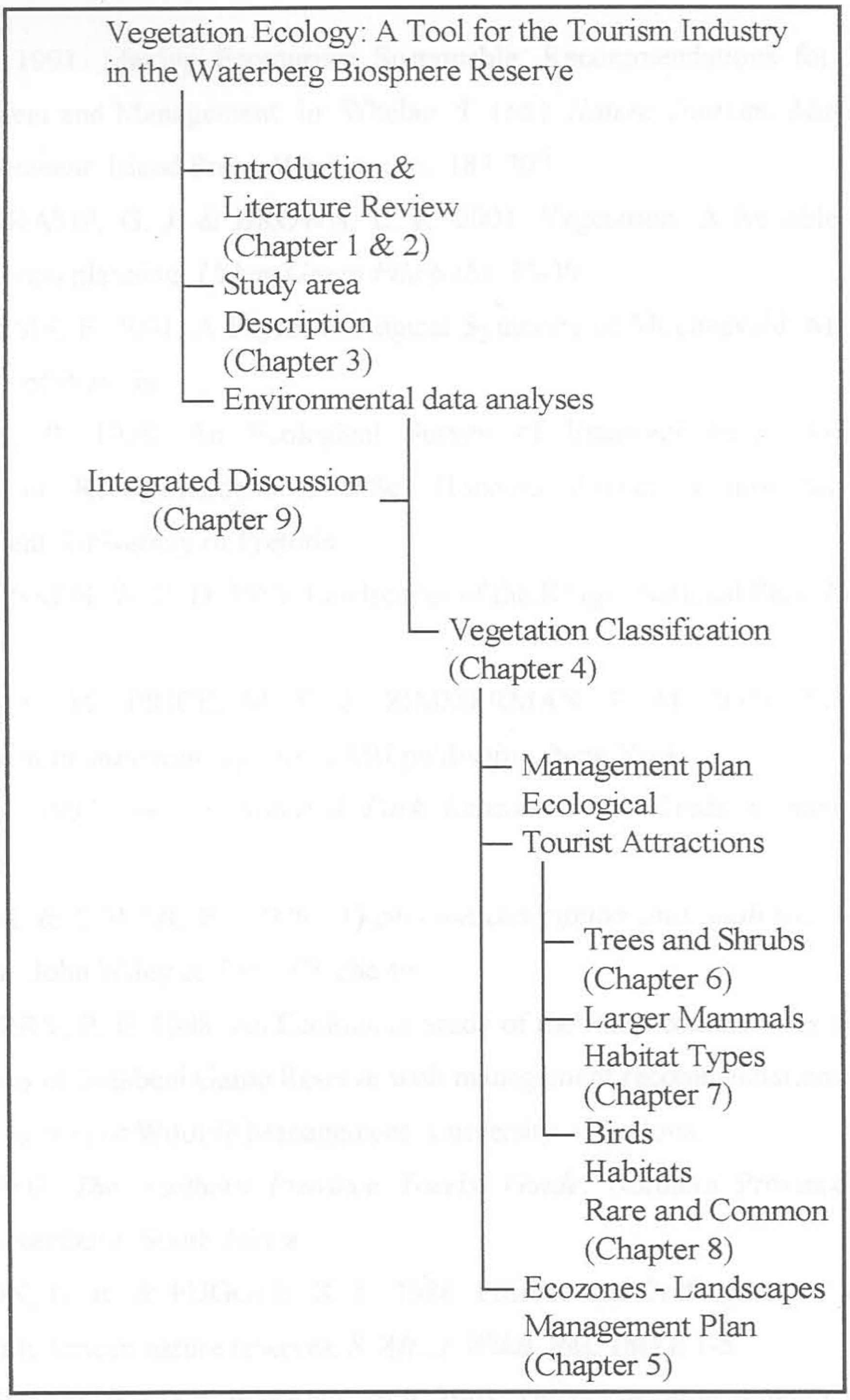

Figure 1.2 Scope and Structuring of Dissertation

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CHAPTER 2
TOURISM AND NATURAL RESOURCE CONSERVATION AND MANAGEMENT IN PERSPECTIVE

2.1 Introduction

Perhaps no other activity has grown world-wide during the past decades with the same speed and global dispersal as tourism. Such growth has inspired increasing dialogue among practitioners, policy-makers, academics and other tourism stakeholders about the form and function of tourism in the next millenium (Godde *et al.* 2000). Activities in the sectors of transport, accommodation, catering, retailing, historical and other attraction management, play a major role as part of the tourism industry. These well-known aspects make tourism one of the world's largest and most significant in terms of turnover, employment and visibility, and therefore does not require a long regurgitation of statistics (Brown, 1998).

The impacts on the natural environment of outdoor recreation, including ecotourism, are extensive and increasing, focusing more and more on the world's remaining natural areas (Liddle, 1997). Not only are we seriously starting to question the impacts of tourism on the biosphere, we are taking more directed action toward the sustainable maintenance of precious resources (Godde *et al.* 2000). These trends in natural resource management are very much applicable to ecotourism management and planning (Ryan, 1991), especially in an area like the Waterberg area, Limpopo Province, South Africa, where ecotourism might have impacts on sensitive areas. However, although certain human impacts might have a negative effect on the environment, the value of the natural resources of an area towards ecotourism cannot be underestimated and should be incorporated as part of the conservation, management and promotion of such areas.

2.2 The tourism phenomenon

From the dawn of time humans have been on the move. The first written record of an actual traveler is found in Genesis, the first book of the Bible. Cain, the son of Adam and Eve, was banished from the Garden of Eden for killing his brother and told he was to become a wanderer of the earth. Two major factors in the overall evolution of tourism from here on are man's development of a system to transport himself rapidly over great distances and the development of an industry concerned with housing and feeding humans away from their homes (Kreck, 1972). Tourism today, can be viewed as:

- A social phenomenon, not a production activity
- The sum of the expenditures off all travelers or visitors for all purposes, not the receipt of a select group of similar establishment
- An experience or process, not a product - an extremely varied experience at that (Theobald, 1998).

The demand for tourism is determined by a number of economic, psychological and social factors (Ryan, 1991). Tourism has grown significantly in both economic and social importance, and today, tourism is most certainly the concern of a number of world governments since it not only provides new employment opportunities, but it also produced a means of earning foreign exchange.

2.3 Tourism worldwide

International tourism is emerging as a leading global economic driver for the 21st century [World Travel and Tourism Council (WWTC), 1998]. In 1972, the tourism industry already totaled well over US$ 20 billion which was expended by more than 110 million travelers from 125 countries (Kreck, 1972). Today, travel and tourism - encompassing transport, accommodation, catering, and services for travelers - is one of the world's largest industries and creators of quality jobs. Worldwide, in 1998, it was expected to generate US$ 4.4 trillion of economic activity, forecast to grow to US$ 10.0 trillion by 2010. Travel and tourism is a high growth activity, which is forecasted to increase its total economic activity by 4.1% per annum worldwide in real terms over the next twelve years (WTTC, 1998).

Travel and tourism is also human resource intensive, creating quality jobs across the full employment spectrum. In 1998 1 in 10.7 jobs was generated worldwide by the tourism economy. The travel and tourism industry accounted for about 3.2% of global employment at the time. It was also estimated that the figure of 79.2 million travel and tourism industry jobs held, would have increased to 116.8 million by 2010 (WTTC, 1998).

Tourism is an extremely complex endeavor. Not only are huge amounts of money at stake; in addition, economic incentives are provided to protect the natural environment, restore cultural monuments, and preserve native cultures. The tourism industry is in a small, but important way, contributing to understanding among people of very different backgrounds. But above all, it provides a break from the stress of everyday routine and fulfilling the dreams of leisure travelers (Theobald, 1998).

2.4 Tourism in South Africa

With a population of approximately 41 million and a land area of 1.27 million sq. km (nearly five times the size of the UK), South Africa's resource base for tourism is phenomenal (DEAT, 1996). In fact, the prospects for the tourism industry are better now than they have been for decades. Foreign tourism has experienced dramatic and sustained growth over the past few years and domestic tourism is set to grow steadily off a large base. This is in spite of some political instability in neighboring countries, and the lack of foreign investment and adequate economic growth over the last few years, as well as an increased perception of robberies and violence in certain parts of the country.

South Africa's tourism attractiveness lies in its diversity. Some of the features which make South Africa an incredibly attractive tourism proposition include: Accessible wildlife, varied and impressive scenery, unspoiled wilderness areas, diverse cultures (in particular traditional and township African cultures), generally sunny and hot climate, no "jet lag" from Europe, a well-developed infrastructure and virtually unlimited opportunities for special interest activities such as whale-watching, wild water rafting, hiking, bird-watching, bush survival, deep-sea fishing, hunting and diving. In addition, unique archaeological sites and battlefields, the availability of excellent conference and exhibition facilities, a wide range of sporting facilities, good communication and medical services, internationally known attractions (Table

Mountain, Cape of Good Hope, Sun City, Kruger National Park, Garden Route) and unrivaled opportunities to visit other regional internationally known attractions (e.g. Victoria Falls and the Okavango Swamps) make South Africa an almost complete tourist destination (DEAT, 1996).

Southern Africa also has 10% of all plant species in the world, even though our country's land surface is less than 1% that of the globe. South Africa is also the only country to totally contain one of the world's six Floral Kingdoms - The Cape Floral Kingdom which mostly consist of Fynbos. One third of South Africa's 24000 plant species occurs in this adverse, rich Kingdom. The vegetation of South Africa further consists of 7 biomes namely Fynbos, Savanna, Nama Karoo, Succulent Karoo, Thicket, Grassland and Forest (Low & Rebelo, 1996). According to Low & Rebelo (1996) these biomes can further be divided into 68 specific vegetation types as previously studied and described by several authors like Rutherford & Westfall (1986) and Rebelo (1994). This not only creates an absolute haven for botanists and field naturalists, but also adds aesthethic value to the country's rich landscapes as well as providing several opportunities for tourism, for example the annual flowering of the Mesembryanths and other plants in the Northern Cape or Namaqualand.

2.4.1 Strengths and weaknesses of tourism in South Africa

South Africa has tremendous advantages in the global tourism market and some critical challenges (WTTC, 1998).

The advantages for tourism in South Africa are:

- The characteristics of South African tourism products are in line with global market trends for adventure tourism, ecotourism and cultural tourism
- Since 1994 there has been significant increased capacity for tourism in accommodation, transport and airlinks
- There has been increased co-ordination of tourism initiatives in Southern Africa for expansion and increased diversity of products
- It represents exceptional value for money for visitors from key origin markets

- It has a positive international image for its democratic political transformations (WTTC, 1998)

Notwithstanding all the above-mentioned advantages, the country has not been able to realise its full potential in tourism (DEAT, 1996) due to the following reasons:

- Some parts of are increasingly seen as unsafe for tourists
- There are gaps in infrastructure and lack of capacity in some areas
- Product quality and service levels do not always meet international standards

The future prosperity of the "tourism industry" sector will be assured only if these advantages are consolidated and the weaknesses minimised (WTTC, 1998).

2.4.2 The tourism industry in South Africa

The tourism economy of South Africa is estimated to be worth more than US$ 10 billion per year, contributing more than 8% of the country's total Gross Domestic Product (GDP) (DEAT, 1998). The potential economic growth for tourism in South Africa is phenomenal in all aspects concerned, especially in the employment division. To secure the healthy and sustainable tourism growth in South Africa it is essential that a collaborative approach be followed in developing the industry. The White Paper (DEAT, 1996) and the Tourism in GEAR (DEAT, 1997) espouse such an approach by indicating that tourism should be led by the government and driven by the private sector, and be community-based and labour-conscious (DEAT, 1999).

2.4.3 Tourist Market segments in South Africa

As stated previously, the tourism sector of South Africa offers many attractions to tourists. The following tourism segments have been identified as offering the fastest growth potential for the international tourism market namely cultural, conference, sports, adventure and ecotourism (DEAT, 1998). Ecotourism is certainly one of the most popular tourist attractions in South Africa, and concerning the environment needs the most attention from an ecological point of view.

2.4.4 Ecotourism

There are generally few opportunities to earn income from protected areas. Therefore, constant problems arise in financing their establishment and management (Tisdell, 1999). Ecotourism involves the environmentally and socially responsible travel to such natural or near natural areas that promote conservation (DEAT, 1996). It further has low visitor impact and provides one of the few opportunities to earn income from these areas (Tisdell, 1999).

South Africa offers an incredible diversity of eco-attractions. South Africa has a total of 212 parks and game reserves that offer eco-tourism experiences, 17 of which are major national parks including the 2 million hectare Kruger National Park. Eco-tourism plays an important role with South Africa's wildlife and scenery remaining the enduring reasons for foreign visitors coming to the country. In 1997, the economic contribution of eco-tourism was estimated at R16.6 billion, and this figure was expected to increase to R30 billion in the year 2000 (DEAT, 1998).

Tourism to natural areas is economically important in many developing countries (Tisdell,, 1999). However, the management and conservation of such natural resources needs priority in order to conserve the biodiversity and to sustain their present status.

2.5. Trends in Natural Resource management

Nature is under continuing threat from humankind and the world's biodiversity continues to decline at an alarming rate (Barbier *et al.* 1994). Natural resource development indicates the concept whereby environmental resources are given specific value owing to development. Resource management is an even wider concept, which involves controls relating to the amount, quality, timing, availability and the general direction of resource development. It examines strategies and technologies for resource development in order to sustain economic growth without causing environmental degradation and destruction (Hugo *et al.* 1997).

2.5.1 The importance of sustainable development

Like "tourism" the term "development" is complex embodying a number of ideas accumulated and revised in recent decades. Development implies change: "A Process that improves living conditions of people relating to non-material wants as well as to physical requirements" (Godde *et al.* 2000). The raised awareness of the destructive effects of development on the environment in the latter half of this century has led to the now generally inseparable adjective in the concept of "sustainable development" (Godde *et al.* 2000).

The objective of resource conservation is to manage natural resources sustainably. Sustainability involves the long-term maintenance of natural resources with minimal adverse environmental impacts and adequate economic returns (Jordan, 1995). Meffe & Carroll (1997) defined sustainable development as human activities guided by acceptance of the intrinsic value of the natural world, the role of the natural world in human well-being, and the need for humans to live on the income from nature's capital rather than on capital itself. They posed the question: "Can we make qualitative changes in complexity and configuration within existing human systems that do not place increasing quantitative demands on natural systems, and are in fact compatible with their continued existence?"

Viederman (1992) provided 7 principles of sustainability, to attain sustainability for the good of humanity and the natural world:

- Nature should be understood to be an irreplaceable source of knowledge, from which we can learn potential solutions to some of our problems
- Issues of environmental deterioration and human oppression and violence are linked in analysis and action
- Humility must guide our actions. Good stewardship begins with restraint
- We must appreciate the importance of "proper-scale". Place and locality are the foundation for all durable economics, and must be the starting point of action to deal with our problems. Solutions are local and scale-dependent.

- Sufficiency must replace economic efficiency. The earth is finite, and that fact must be accepted in order for humanity to adopt limits. Living within our needs on a planetary scale does not mean a life of sacrifice, but of greater fulfillment. We must distinguish between "needs" and "wants"
- Community is essential for survival. The global community should reflect and encourage diversity while being interdependent
- Biological and cultural diversity must be preserved, defended, and encouraged

As societies struggle to understand the term "sustainable development", it is believed that the two operational measures of sustainable ecosystem management, namely biodiversity and ecosystem processes, offer a way to a sound definition of sustainable development. If all ecosystems on earth were managed sustainably, the sum would be equivalent to sustainable development on a planetary basis (Meffe & Carroll, 1997).

2.5.2 The human presence

Humans are and will continue to be a part of both natural and degraded ecological systems, and their presence must be included in conservation planning. In recent years, considerable thought and effort have been given to devising development methods that are more culturally and environmentally suitable and thus more sustainable. Nature reserves are typically surrounded by lands and waters intensively used by humans, and therefore it is impossible to isolate reserves completely from these outside influences (Meffe & Carroll, 1997). Jordan (1995) believes that the only hope for preserving biological diversity of tropical forests is to allow people who live in the forest to sustain themselves from that forest. The users of the forest then become its guardians. The question remains however, whether the resources will remain sustainable, given an expected increase in the demand for those resources.

Although the human presence might be seen as negative towards conservation, there are benefits to be gained by explicitly integrating humans into the equation for conservation. This can be done by adopting the following strategies mentioned by Meffe & Carroll (1997):

- **Indigenous knowledge** is obtained from people who have been longtime residents in the region of a reserve, and often know a great deal about local natural history. The knowledge can be useful in developing reserve management plans
- Reserves should be **user-friendly** in order to build public support. If people do not perceive that the reserve has any value to them, they will not support it. Ecological knowledge about reserves should be presented both formally and informally in educational programs (Meffe & Carroll, 1997). The idea is to overcome the alienation of individuals from nature. It is believed that when humankind has the opportunity to co-exist with nature and achieve harmonious relationship with it that this leads to more harmonious and stable communal relationships. Supporters of the community concept of sustainability usually favour the preservation of biodiversity (Tisdell, 1999).
- Native human cultures are a part of the ecological landscape and have an ethical right to areas where they live. Some of these cultures have developed sustainable methods of existence that can serve as models for modern sustainable development. The incorporation of the problems of modern cultures should also be incorporated into conservation, since they have the largest influence on resource use (Meffe & Carroll, 1997).

2.5.3 Conservation of biodiversity

Biodiversity is a term that refers to the variety of living organisms, their genetic diversity, and the types of ecological communities into which they are assembled (Meffe & Carroll, 1997). Conservation of biodiversity is one of the most important aspects of ecologically sustainable development. It requires that economic development be consistent with preserving the diversity and integrity of nature (Tisdell, 1999).

An important part of conservation is the preservation of species of flora and fauna that inhabit the earth. International treaties and national law protect species by making it illegal to kill them or trade them. On the international level, the most significant step has been the signing of the Convention on International Trade in Endangered Species (CITES) by the majority of the world's nations. In the United States, the Endangered

Species Act has attacked the problem of species loss (Jordan, 1995). Although individual species may be exterminated because of their commercial value, the major threat to world biodiversity comes from habitat destruction. Habitat destruction is the most prevalent cause of species endangerment (Wilson, 1992). Thus, although a focus on species conservation may be most effective in conserving charming species like pandas or commercially viable flora such as mahogany, conservation of biodiversity and ecosystem functions may be best achieved by preserving habitat (Jordan, 1995). The problems and challenges facing humanity with respect to conserving biodiversity can seem overwhelming, and consequently their solutions can appear diffuse and ineffective. However, Meffe & Carrol (1997) believe that concentration on the following five areas of effort could result in major advances toward conserving biodiversity and developing a sustainable human society, compatible with the natural world, at a reasonable standard of living:

- First stabilize, then reverse human population growth
- Protect tropical forests and other major centres of biodiversity
- Develop a more global perspective of earth's resources, while solving problems locally wherever possible
- Develop ecological economics to replace growth economics
- Modify human value systems to reflect ecological reality

It is necessary to recognize that the loss of species from a particular ecosystem may threaten the functioning of the system as whole, depending upon the paths of interdependence between species. Whether this loss is likely to create greater impairment to the functioning of ecosystems with less diversity than those with greater diversity is unclear. Nevertheless, as the diversity of species in a region is decreased, the sustainability of ecosystems in the region, and the services provided by ecosystems, are likely to be increasingly impaired (Tisdell, 1999).

2.5.4 Ecosystem management

Clark & Zaunbrecher (1987) defined ecosystem management as the management of natural resources using system-wide concepts to ensure that all plants and animals in ecosystems are maintained at viable levels in native habitats and the basic ecosystem processes are perpetuated indefinitely. Jordan (1995) believes that natural occurring ecosystems are the nearest thing to sustainable systems. They are "ecologically sustainable" in the sense that there are no artificial energy, nutrient and water subsidies. However, as soon as humans begin to extract resources from a system, for example game or timber, output of the ecosystem is greater than the input, and the system is no longer sustainable.

Ecosystem management is essentially an expansion of natural resource management and human-land relationships in three dimensions: time, space and degree of inclusion. The temporal dimension is expanded because we are concerned with the health and vitality of ecosystems into the indefinite future. Management goals must include ensuring the ecosystem dynamics occur within ranges that do not exceed the resilience of the system. The second aspect, the spatial dimension, is expanded beyond a particular small plot of ground to include the larger landscape and connections to other landscapes (e.g. biosphere reserves). It is important to recognize and understand the spatial connections present in nature to more effectively manage these systems. Ideally, the spatial scale should include sufficient heterogeneity to provide resources for species during years of scarcity. Finally, the human dimension is expanded to include a broader diversity of interest, talents, and perspectives in natural resource decision making. Single-institution, top-down, command- and control decision making will not suffice in true ecosystem management, for it can exclude the majority of persons and interests affected by the decision and can ignore relevant information and talents that could contribute to problem solving (Meffe & Carroll, 1997). Jordan (1995) further believed that no countries in the world could survive based on ecological sustainable production systems alone. To maintain modern civilizations and present-day populations, production systems must be modified and subsidized.

2.5.5 Ecotourism, conservation and sustainable development

Various types of tourism that have arisen over the past few decades, such as ecotourism, nature-based tourism, alternative tourism and small-scale tourism are indicative of the higher level of awareness towards the natural environment. The need for sustainable tourism development is gaining attention and "ecotourism" is being promoted by many developing countries as an impetus to expand both conservation measures and tourism development (Theobald, 1998).

Many individuals regard ecotourism as a tool for sustainable tourism development, combined with sound planning and management. Ecotourism can also help in the promotion of natural, social, cultural and economic improvement for sustained conservation efforts. With growing interests in nature conservation, interest in the economic possibilities of ecotourism has increased. The appeal of ecotourism is that it may allow nature conservation and economic gain to be combined, thereby providing an economic incentive for nature conservation (Tisdell, 1999). The original World Conservation Strategy (IUCN, 1980) pointed out that nature-based tourism may provide a means by which developing countries may at least recoup some of the costs of conservation of biodiversity. The future of ecotourism in such countries is bright, although the viability of such destinations may be largely dependent upon the extent to which those destinations are able to implement sustainable development practices while attracting their share of the international ecotourism market. Government policy makers and tourism industry officials must accept the challenge, the responsibility and the mandate of bringing market forces into congruence with the need for environmental protection and social equity. If this can be accomplished, ecotourism may well become an example of how development can be achieved on a sustainable basis to the benefit of visitors, hosts and industry alike (Theobald, 1998).

Although ecotourism has the potential to encourage conservation of the natural environment, it is also true that tourism which utilizes the environment can result in its deterioration (Tisdell, 1999). It is therefore extremely important to know what the potential negative impacts of ecotourism can cause to natural environments, to implement management and planning procedures in time.

The importance to conserve our natural resources to promote ecotourism, as well as the value of these resources as basis for ecotourism activities cannot be underestimated. Large conservancies in the Southern African savannas, like the Kruger National Park in South Africa contribute largely to ecotourism and conservation. These savanna systems are dynamic and need to be fully understood when linked to ecotourism activities. Ecological management is therefore essential for the conservation of savannas.

2.6 Conservation of the Southern African savannas

Savannas in general can be defined as a vegetation biome with a continuous grass layer, usually scattered with trees (Bourliere, 1983). Savannas in Southern Africa can be described in more detail as all ecosystems in which C_4 grasses potentially dominate the herbaceous stratum and where woody plants, usually fire-tolerant, vary in density from widely scattered individuals to a closed woodland broken now and again by drainage-line grasslands (Huntley & Walker, 1982).

The vegetation ecology of the savanna biome in Southern Africa has been studied extensively in previous years (Rattray, 1962; Van Rooyen, 1978; Van der Meulen, 1979; Bredenkamp, 1982, Gertenbach, 1987, Scholes, 1997) and represent the largest biome in Southern Africa, occupying 46% of its area, and over one third of South Africa (Low & Rebelo, 1996). Most of these publications are strictly scientific, and there is a definite need to produce more books like " The Magnificent Natural Heritage of South Africa" (Knobel, 1999). This popular presentation brings information on the savanna and other biomes of South Africa to the public. The book combine photography with facts about the environmental aspects of the biomes, and presentations like this is important in making the public more aware of their surroundings and conservation.

The savanna functions as several dynamic ecosystems [25 vegetation types have been described by Low & Rebelo (1996)], and is rich in biodiversity, with conservation playing a major role in the many National Parks and reserves in this biome.

2.6.1 Biodiversity

Southern African savannas are rich in its biodiversity concerning several aspects of ecosystems. Firstly, savannas can be divided into Moist Savanna and Dry Savanna (Booth *et al.*, 1994) on the basis of biotic patterns, which coincide principally with moisture availability. The geographical distribution of many of these moist and arid savanna plant species overlap widely, but their habitat preferences result in a clearly defined ecological separation which is only detectable in the field. The division of moist and arid savannas also conforms with the distinction between "sweet" and "sour" bushveld based on the maintenance or loss of grazing value through winter (Huntley & Walker, 1982). This is also reflected in Acock's (1988) classification of South African vegetation into sweet, mixed and sour bushveld and grassland types. Figure 2.1 shows the distribution of the arid and moist savanna types through Africa south of the Equator.

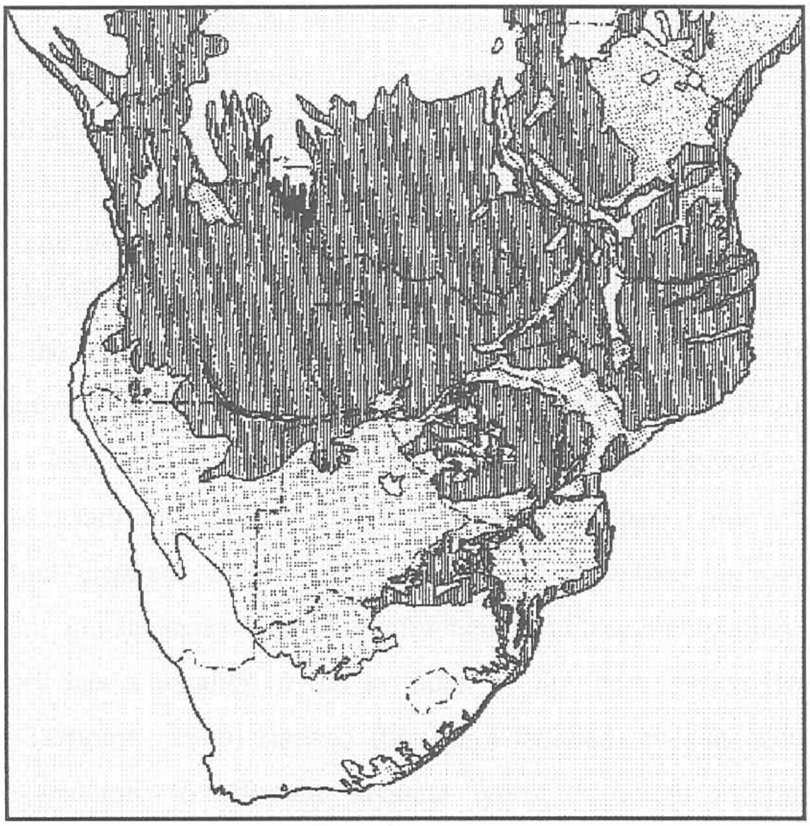

Figure 2.1. Distribution of arid (stippled) and moist (vertical stripes) savannas south of the Equator (Huntley & Walker, 1982)

The biodiversity of Southern African savannas is further emphasized by the concept of physiognomic structure of plant communities or vegetation types. Most savannas are characterized by a grassy ground layer and a distinct upper layer of woody plants (Rutherford & Westfall, 1986). Bredenkamp (2002) and Du Plessis (2001) showed how dynamic these different structural layers (especially the grassy layer) could be by interpretation through the Equilibrium- non-Equilibrium models. Where the upper, woody layer is near the ground the vegetation may be referred to as Shrubveld, where it is dense as Woodland, and the intermediate stages are locally known as Bushveld (Rutherford & Westfall, 1986). Van der Meulen & Westfall (1980) further showed how aspects like altitude, soil type, overgrazing and fire can cause floristically similar woodland or bushveld vegetation in the western Transvaal, South Africa to be quite different structurally.

Most data on plant species richness apply to territories of varied area. The floristic richness of the African savannas stand out clearly: their average area richness (1750 species per 10 000km^2) is not much lower than that of the rain forests (2020 species per 10 000km^2). The floristic richness of Africa south of the equator is also much greater than north of it (Bourliere, 1983).

The savanna biome is also rich in terms of faunal patterns and relationships. An examination of the distribution of the mammals of Southern Africa shows a marked correlation with the moist and arid savannas. Certain species like black rhinoceros, red hartebeest springbok are more confined to arid savannas (sweet), while the low density ungulates like sable antelope, grey duiker and common reedbuck prefer the high bulk and low nutrient value of the moist (sour) savannas. Other widespread species like buffalo, elephant, eland and Burchell's zebra reach their highest densities in the nutrient rich arid savannas. The distinction between these mammalian faunas of the savanna types has a parallel in the avifauna of Southern Africa (Huntley & Walker, 1982). Tarboton (1980) showed through a detailed analysis how specific birds could be endemic to adjacent savanna types. Although information on invertebrate zoogeography of savannas in Southern Africa is scarce, Huntley & Walker (1982) pointed out that a clear distinction between nutrient and energy pathways are followed in the two savanna types. This should give a clear explanation to why specific insects and other invertebrates prefer certain habitats within the savanna types. For example, in moist savannas, primary production is high in structural materials and low in nutrients, consequently the value to herbivores like insects is very low.

The conservation of biodiversity within the Southern African savannas can never be overemphasized. Therefore the importance of the region's the National Parks and reserves cannot be underestimated. An excellent example of a Southern African savanna in conserving biodiversity is the Kruger National Park, South Africa. The park constitutes an area of 20 000km^2 hosts almost 150 mammal species, more than 500 bird species, 51 fish species, 119 reptiles species, 35 amphibian species and more than 2000 documented plant species, including some 450 tree species and 235 grasses (Van Rooyen, 1999).

2.6.2 National Parks and reserves

Protected areas like national parks and game reserves were originally established for the conservation of large mammals, but also to cover representative samples of ecosystems and habitats, as well as the vast range of species of plants, mammals, reptiles, birds, amphibians and invertebrates (such as insects). Relative to its size the protected areas network is quite extensive, perhaps unequalled in the world. Over 90 percent of known mammal, amphibian and reptile species are represented in protected areas, mostly savannas, making Southern Africa a popular tourist destination. Of the region's total land area of almost seven million square kilometers, over one million square kilometers are designated as protected areas (Figure 2.2) (Booth *et al.*, 1994). Southern Africa has one of only two national parks larger than 50 000km^2 in Africa. It further has the greatest combined park area, the greatest percentage area accounted for by national parks and the highest perimeter: area ratio compared to other parts of Africa (Siegfried *et al.* 1998).

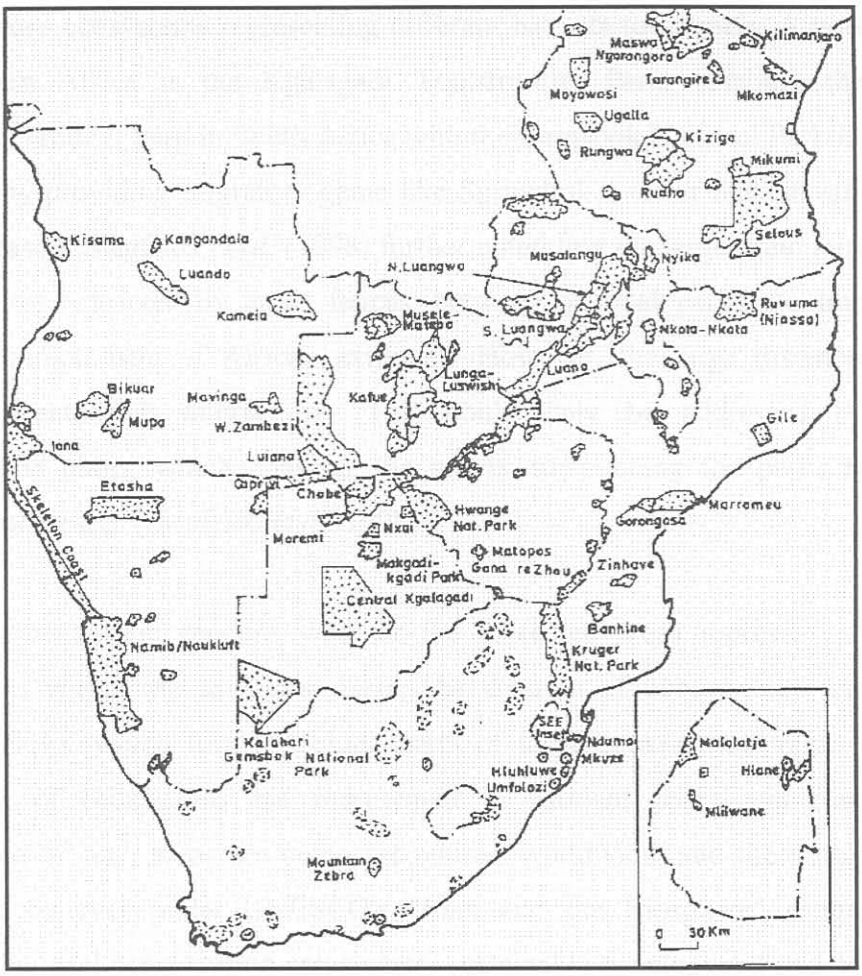

Figure 2.2. The protected areas network of Southern Africa (Booth *et al.* 1994).

The conservation of savanna is good in principle, mainly due to the presence of large parks such as Kruger, Hwange, Chobe and Kafue National Park. However, the large area conserved in South Africa, belies the fact that half of savanna vegetation types are inadequately conserved, in having less than 5 percent of their areas in reserves. However, much of the area is used for game farming and may be considered effectively preserved, if sustainable stocking levels are maintained. (Low & Rebelo, 1996).

Although the conservation of savannas is good in southern Africa, the area needed by wildlife is sometimes of concern. East (1981) have shown that very large reserves ($> 10\ 000\ km^2$) are necessary to ensure the survival of diverse large mammal communities characteristic of the African savannas. In this respect, developments such as transfrontier parks between countries provide animals with corridors and include more ecosystems representing different habitats to animals. A good example in southern Africa is the Kgalagadi Transfrontier Park, combing the Kalahari Gemsbok National Park in South Africa with the Gemsbok National Park in Botswana and thereby providing migratory game like Springbok a wider habitat variety during the dry season. Siegfried *et al.* (1998) further noted that the large-scale movements of animals, not restricted by game fences, between national parks are important for species characteristic of African savannas. However, the large distances between parks prevent such interactions. This could only be addressed by regional conservation plans, which consider the matrix surrounding the parks and aim to maintain processes (Siegfried *et al.* 1998).

The question further remains whether the protected areas represent all types of ecosystems within the savannas. Here, the creation of conservancy areas outside national parks, which further include parts of these ecosystems, might ensure the protection of ecosystems not represented in national parks and reserves. The importance of such areas are being recognized worldwide, and the proclamation of biosphere reserves under UNESCO's "Man and the Biosphere" program, might provide the ideal conservation areas where sustainable development and conservation can take place.

2.6.3 The concept of Ecozones

The natural units, which make up the environment, are called ecological zones or "ecozones". An ecozone is a large natural unit, controlled by a set of common processes, mostly climatic, and is dominated by life forms with similar physical adaptations to these processes (Booth *et al.* 1994).

Scientists use geology, rainfall, vegetation and soil to define ecozones, but attach different importance to a combination of factors. In fact, scientists do not agree on exactly where ecozones are or how to define them (Booth *et al.* 1994). The identification of ecozones can be at a large scale. Rutherford & Westfall (1986) identified the biomes of South Africa as ecozones, while Huntley & Walker (1982) further divided the Savanna biome into moist and arid savannas, as previously described.

However, ecozones can also be defined on a smaller scale, especially in areas within a biome where climatic, geological or vegetation differences occur. Vegetation is considered being a good criterion for defining ecozones because it embodies all the conditions in which animals live. Soil provides nutrients and stores water that plants use. Sunlight, temperature and rainfall patterns affect the plant's ability to grow and survive. Animals which graze on grasses or browse on leaves affect the plants, and fire can stimulate vegetation growth or clear an area, making room for other plant species. Low & Rebelo (1996) identified 68 vegetation types within the 7 biomes in South Africa. The boundaries of the vegetation types were drawn from geological, pedological, climatological, satellite and other cartographic data known to be relevant to the vegetation type. These vegetation types can therefore also be referred to as ecozones.

The identification and mapping of ecozones can further defined on an even smaller scale, especially within conservation areas like national parks. Gertenbach (1983) identified 36 landscape within the Kruger National Park, South Africa and classified them according to vegetation communities that occur within the specific landscape. Certain of these landscapes were later grouped together to form ecozones according to specific similarities within vegetation, geology and climate. These ecozones were described in a tourism booklet and provided tourists with useful information on the vegetation within the landscape on a catena, animals to be seen, soils and geology (Jacana, 1997). The value of these ecozones within National parks, reserves and conservancy areas towards tourism, cannot be underestimated and might be useful as broad ecological management units.

From above mentioned aspects it is clear that vegetation is an integral part of ecosystems. An ecosystem is a functional natural system where there is an interaction between an abiotic component (the physical environment) and a biotic component (the living organisms in the physical environment). Every set of physical environmental variables on a particular site forms the habitat for a set of associated plant species, known as a plant community. Different ecosystem types thus represent different plant communities. These plant communities form the smaller units of the larger ecozone, distinguishable as the large unit within a certain area (Bredenkamp, 2002).

2.6.4 The Waterberg area as ecotourist destination in a South African savanna

Tourism in South Africa is growing rapidly, especially in the Limpopo Province where tourism potential has only been discovered in the past few years. Table 2.1 shows the tourism sector statistics:

Table 2.1 Tourism sector statistics of the Limpopo Province

	International Market	Domestic Market
Size of Market	98 000 visitors	1 132 200 trips
Value of Market	R382 million	R1051 million
Average duration of stay	5.4 nights	5.3 nights

As seen in Table 2.1 the size and value of the domestic tourism market in the Limpopo Province is much larger than the international market. However, since the international market's size is based on holiday trips, while the size of the domestic market is based on professional and holiday trips, the differences cannot be compared to each other substantially. The size of the domestic market is mainly thanks to the tourism developments in the Waterberg area in places like Lapalala Wilderness area, Mabula Game Lodge and Marakele National Park.

The Waterberg forms part of the Central Savanna of South Africa. Winterbach (1998) identified four major vegetation types representing phytosociological classes namely: the *Commiphoro mollis-Colophospermetea mopani*, the *Panico maximi-Acacietia tortilis*, the *Terminalio sericeae-Combretetea apiculati* and the *Englerophyto magalismontani-Acacietea caffrae*. The dominant vegetation type within the Waterberg area is known as Mountain Bushveld, representative of the *Englerophyto magalismontani-Acacietea caffrae* class, although the *Terminalio sericeae-Combretetea apiculati* class is also well represented within the area. The vegetation forms the basis for the ecological management of tourist destinations within the area. Several studies previously performed emphasize the importance of ecological management in the area (Westfall, 1981; Westfall, 1985; Schmidt, 1992; Joubert, 1998; Newberry, 1998).

The Waterberg area has a long cultural history of human occupation and has been inhabited by a succession of people over hundreds of thousands of years. From Stone Age people, the San (bushmen), Khoikhoi herders and Iron Age people, all have left traces in the form of paintings or iron smelting furnaces. It is becoming one of the most important San rock art sites in South Africa. The Waterberg cultural museum near Melkrivier, houses fascinating information on the cultural history of the area (NPTB, 1999). These cultural resources contribute in promoting the area as tourism destination, although it is still the area's natural resources that mainly contribute to its splendor as destination.

The Waterberg basin supports part of the Savanna biome of 14 500 km^2 (NPTB, 1999). It lies in an area of the South African savanna consisting mainly of two vegetation types, namely Waterberg Moist Mountain Bushveld and Mixed Bushveld (Van Rooyen & Bredenkamp, 1996[a,b]). Acocks (1988) described three variation namely Sour Bushveld, Sourish Mixed Bushveld and Mixed Bushveld. The northern part is somewhat drier and contains some elements of Arid Sweet Bushveld (Acocks, 1988). The vegetation of the Waterberg is well conserved and several plant endemics like *Encephalartos eugene-maraisii* and *Combretum nelsoni* occur in the area. The vegetation also creates suitable habitats for animals, birds and insects (Bredenkamp & Brown, 2001) and therefore the potential to create ecotourism destinations has great potential.

The Waterberg area as tourist destination, is still relatively unknown to many and has been described as South Africa's best-kept secret. The mountain range has great aesthetic values and is simply a geographical wonder. The area lies in the bushveld region of the Limpopo Province, South Africa and forms the "heart" of the game and cattle farming industry in the savanna biome of Southern Africa (Van Rooyen & Bredenkamp, 1998). Wildlife conservation has taken most of the place of early farming practices, and today, land-use on vast tracks of the Waterberg mountain range and plateau have changed from conservation in one form or another. Apart from the Marakele National Park and Provincial and tribal reserves, there are literally hundreds of exemption game farms within the area, with an ever increasing number of cattle farmers switching to game farming (Walker, 2000). The 75 mammal species encountered here include big game such as elephant, lion, white and black rhino, leopard, buffalo (Big five) and hippo (NPTB, 1999). It is also a bird watcher's paradise with more than 300 bird species. Ecotourist activities such as guided bush walks, day and night game drives, farm tours, birdwatching, horse riding safaris, fishing, hunting and mountain bike trials are common and very popular (NPTB, 1999).

The Waterberg area, being a relatively under-populated area in terms of human numbers, unsuitable to forestry, without any mineral wealth is an unspoilt wilderness area with tremendous potential for ecotourism development. The area was previously known as the Waterberg Conservancy, consisting of about 150 000 ha. The Conservancy had some 25 members, employing more than 1000 people. However, the tourism industry was under tremendous pressure to generate direct and visible opportunities and benefits to especially the rural communities. It was therefore imperative that a balance was created between conservation and industry that generates visible and direct benefits, like job opportunities, to the local communities (Walker, 2000). These pressures led to the creation of the third South African biosphere reserve namely, The Waterberg Biosphere Reserve.

2.7. The concept of biosphere reserves

The concept of biosphere reserve emerged from the program of Man and the Biosphere (MAB) of which it constitutes an essential part (Batisse, 1982). A biosphere reserve is a protected area of representative environments, internationally recognized for their conservation value and for providing the scientific knowledge, skills and human values to support sustainable development (UNESCO, 1971). These areas can be terrestrial and coastal / marine ecosystems.

Biosphere reserves are designated to deal with one of the most important questions the world faces today: How can we reconcile conservation of biodiversity and biological resources with their sustainable use. It has three primary functions namely development, conservation and logistic. By combining the three functions biosphere reserves become living examples of the integration of sustainable development (like tourism) and conservation. To fulfil the three functions, biosphere reserves comprises three distinct zones as shown in Figure 2.3 [United Nations Educational, Scientific and Cultural Organization (UNESCO), 1971].

The core areas are often publicly or private owned conservation lands such as wilderness areas or nature reserves. These provide a location where ecosystems, which are minimally disturbed, can be monitored and maintained for the future. The buffer zones often adjoin and may surround the core area. Here, research, education, recreation, and a variety of economic activities are conducted based on and agreed upon ecological principles, and within a legally based management framework. The transition areas are the third component in the relationship. These zones are also known as "zones of cooperation" where land-use, such as farms and urban areas, are found. It is within these zones that the development functions of a biosphere reserve are fulfilled within a framework of sustainable natural resource utilization (UNESCO, 1971). The design of these zones within the biosphere reserve will determine the different management practices applied within these reserves.

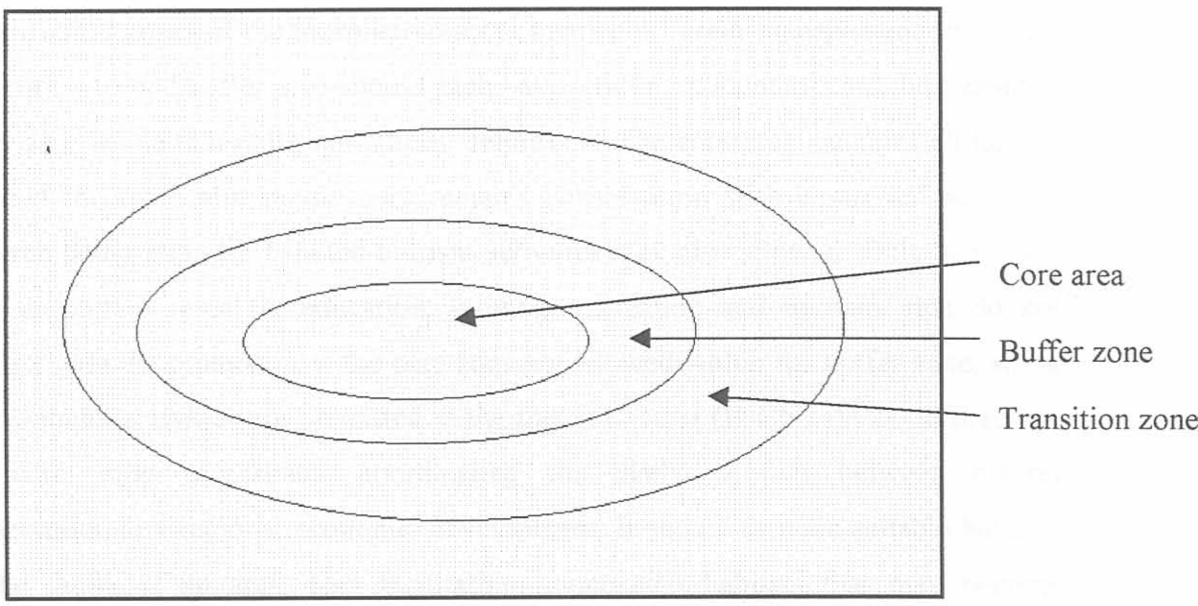

Figure 2.3 Zoning of biosphere reserves

2.7.1. Management of Biosphere reserves

The conservation strategy of biosphere reserves focuses on managing protected areas as well as adjacent lands and communities (Solecki, 1994). It is widely recognized that managing environmentally sensitive land that may represent biosphere reserves, requires incorporating the needs of area residents into the planning process and forging links between the reserves and local residents (Batisse, 1982).

The primary function of Biosphere Reserves remains the *in situ* long-term conservation of plant and animal genetic resources, together with research on ecosystem management and conservation, monitoring of changes in the Biosphere, training of specialists, and environmental education. As representative zonal and azonal ecological areas covering as far as possible all types of natural, semi-natural, and modified ecosystems, biosphere reserves constitute a significant way of improving the partnership between humans and nature (Batisse, 1982).

The different zones of the biosphere reserve involve different management strategies. The core area and buffer area should each have a definite boundary and the transition zone, as, a whole is usually not strictly delineated. The core area excludes all human use and the main aim in the core remains conservation with controlled scientific research being allowed. Limited tourism activities may also allowed. Only activities, such as certain research, education, training, recreation and tourism, that do not conflict with the protection of the core zone are allowed within the buffer zone, while development activities are permitted in the transition area (IUCN, 1992). In practice, the core zone necessitates coordinating the likely conflict between natural conservation and regional economic development. It should provide suitable habitats to the fauna of an area, also facilitating unoccupied habitats that may become available when the population of species increases or food resources are scarce. For practical conservation, any suitable or potentially suitable habitats should not be neglected in the design of the core (Li *et al.* 1999[a]). The buffer zone is a further a key aspect for reserve management because it is a link between the reserve managers and local inhabitants. Experiences show that failure in conservation in a reserve often result from poor design of the buffer zone or no buffer zone around a core (Li *et al.* 1999[b]).

The management of Biosphere Reserves is complicated, and different management policies will mostly be dependent on socio-economic considerations of the local communities.

2.7.2. Socio-Economic issues

Attitudes and incentives of people living around protected areas are widely considered to constrain successful management of these areas (Richards, 1996). It cannot be overstressed that conservation measures- especially those that involve productive lands- will not succeed without the agreement, support, and participation, of the population directly concerned. The biosphere reserve concept is built upon the establishment of a dynamic interaction between scientists, resource managers, decision makers, and the local people who should ultimately benefit from the protection measures and from the results of research (Batisse, 1982). The success of the Mapimi Biosphere Reserve in Mexico was emphasized by the involvement of the local population actively participating in the creation and management of the reserve (Halffter, 1981). This should be seen as an encouragement to all other biosphere reserves around the world.

A primary challenge of biosphere reserves is to educate the public about the concept, while retaining existing support and understanding of other forms of land protection. Any response to this challenge, however, will need to consider somewhat different perceptions and values attached to land protection in industrially developed, as compared with developing - in particular third world countries (Kellert, 1986).

In the industrial nation's context, the primary need is to resolve the tension of a largely aesthetic as contrasted with ecological appreciation of land protection. Considerable public support exists for protecting areas of aesthetic, historic, and humanistic, values, although relatively little understanding is apparent regarding the ecological benefits of land protection, or the potential worth of designating core and buffer zones to assure that relatively pristine areas are adequately conserved. Any effort at increasing public support for the biosphere reserve concept in socio-economically developed nations should emphasize the values derived from preserving biological diversity and representativeness, and the dangers associated with creating isolated reserves and island ecosystems (Kellert, 1986).

The primary tension in developing nations however, is reconciling land protection objectives with the resource-dependent needs and utilization traditions of often impoverished subsistence-oriented populations. It is the potential of the biosphere reserve concept to address the socio-economic needs of developing nations that renders such a land protection strategy as a potentially important effort in this social and political context (Kellert, 1986). Lusigi (1981) noted that most of the public in developing countries perceives the conservation of land and wildlife as often a choice of animals and plants over people. The justification for parks as a way of promoting tourism and, thus obtaining needed 'hard' currency is often viewed as taking land from native people for the pleasure and benefits of the foreigners. Of primary concern is how management of protected areas with resident populations can reduce the social consequences of involuntary relocation, residency without access to resources, and assimilation (Rao & Geisler, 1990). Therefore, Batisse (1982) suggested that the biosphere reserves in developing countries should rather be an open system, looking out towards the management problems of the surrounding areas, and incorporating land-use, management concerns of the local populations. The major land protection challenge in third-world nations, however, is to incorporate the socio-economic needs and utilitarian values of local populations into the establishment and management of preserves (Kellert, 1986). It seems as though the policies of governments of both developing and industrial nations might play an important role in the solving of some of these socio-economic problems surrounding biosphere reserves.

2.7.3. Government policies

It is important to note that a biosphere reserve is run by the community and not by a government agency. The government plays a facilitator and advisory role only (Walker, 2000). For example in the lake St. Lucia area, South Africa the government had the role of making the decision on whether the development of mines in an area rich in biodiversity will go ahead (Preston-Whyte, 1996). The state of politics within countries could play a major role when decisions regarding funding for the creation and management of natural areas like parks and reserves have to be made. In the

United States for example, the change in political climate in 1994, caused major budget cuts on natural resources programs to balance the federal budget. Changes in governments could, on the other hand, also have positive impacts. In Russia, after the break up of the former Union of Soviet Socialist Republics (U. S. S. R.) in 1991, the amount of protected areas was drastically increased and at that time, no other country in the world added a greater amount of land area to its system of protected areas (Peine, 1999).

Batisse (1985) noted that despite vigorous action to make governments aware of the importance of biosphere reserves and to promote their establishment, there are still many gaps and deficiencies in the network and that governments should be invited to undertake activities which will improve and expand the international biosphere reserve network, to develop basic knowledge for conserving ecosystems and biological diversity, and to make biosphere reserves more effective in linking conservation and development in fulfilling the broad objectives of MAB.

2.7.4. Ecological Importance

Although these issues described in the previous sections play a significant role in biosphere reserves, one of the main aims within these reserves still remain conservation and maintenance of genetic diversity of plant and animal species and the need to help manage natural resources on a sustainable basis (Dhargalkar & Untawale, 1991). Batisse (1982) showed the importance of biosphere reserves as a tool for environmental conservation and management. The biosphere reserve concept has been put forward by conservationists and land-use planners hoping to improve management of large regional super-ecocomplexes such as the greater Yellowstone "Ecosystem" (Clark *et al.* 1991).

Biosphere reserves play an important role in several ecological aspects of ecosystems. Habitat preferences and distribution of animals and birds often exceed the fences of game reserves, and when the fences do not restrict the animals, the buffer zone of the biosphere reserve provides the added habitat requirement. Grimbeeck (1991) showed that the territories of leopards in the Waterberg area, South Africa, are far larger than only game reserve fences and could be up to 303 km^2, with one leopard per 53 km^2.

Studies done on habitat preferences of animals and birds within larger ecosystems in biosphere reserves also provide useful information on behavioral patterns, distribution and feeding ecology and several studies have been done (Sasvari & Moskat, 1988; Johnson & Franklin, 1991; Aranda & Sanches-Cordero, 1996; Solazano *et al.* 2000). Povilitis (1993) further showed the importance of biosphere reserves in the restoring of megafauna to areas where they occurred before human intervention. This could play an important role in an area like the Waterberg, where a lot of animals where hunted in previous times, and some completely disappeared from the area.

Studies on vegetation within biospheres or large ecosystems have not been done extensively and in future, this aspect should be emphasized. However, some research on large data sets have been performed within Southern Africa biomes by Bredenkamp & Bezuidenhout (1995), Winterbach (1998) and Du Plessis (2001). These studies have showed the value of ecological classification of vegetation types for a better understanding of the system dynamics, management and conservation over larger areas. Phytosociological studies have also been done and described in the larger conservation areas such as the world-famous Kruger National Park (Gertenbach, 1978, Van Rooyen, 1978, Coetzee, 1983, Gertenbach, 1987). Gertenbach (1983) used these vegetation studies, combined with studies on the geology (Schutte, 1982), climate (Gertenbach, 1980) and animal life (Pienaar, 1963) to identify 35 landscapes in the Kruger National Park. These 35 landscapes were later combined to form 16 ecozones based on similarities between the 35 landscapes (Jacana, 1997). The ecozones were presented in an ecozone map, providing tourists visiting the Kruger National Park with valuable information on vegetation patterns, geology and animals to be seen in ecozones.

Krizo & Krizova (1995) showed that taxonomic studies on rare and endangered flora within a Biosphere Reserve provide useful information about the distribution of endangered, very vulnerable, vulnerable, rare, endemic and indeterminate vascular plants. Biosphere reserves further provide a large area for vegetation descriptions along environmental gradients as shown by Springuel *et al.* (1997).

From above mentioned aspects it becomes clear that Biosphere Reserves play a major role in ecosystem management of large ecosystems. One of these aspects that is becoming more and more dominant within the reserves is land-use planning for sustainable tourism.

2.7.5. Tourism within biosphere reserves

One of the fastest growing sectors in the tourism industry is ecotourism, where people are particularly seeking a more intimate experience with nature and/or indigenous culture closely tied to the natural environment. Several aspects should be taken into account when applying ecotourism within conservation areas, as it might have an adverse impact on the environment (Peine, 1999).

Tourism within biosphere reserves plays an important role, not only in the economic aspect, but also in the providing of job opportunities, upliftment and resource development of local communities (Walker, 2000). The ecotours provided to tourists should strive to demonstrate by experience the interconnectedness of indigenous cultures and the natural environment (Peine, 1999). However, the importance of tourism, especially in developing countries has not yet been realized, due to different priorities towards natural resources. Often in these countries, wrong approaches towards, local communities can result in missed opportunities to implement ecotourism in suitable areas as shown by Richards (1996).

However, in developed countries, tourism plays an important role, and the opportunities provided, especially within the buffer zones of Biosphere Reserves for tourism development are immense, and might provide an alternative to solving ecological problems. In the Lake St. Lucia area, South Africa, it is argued that wealth creation through development of ecotourism and mining would achieve sustainable development objectives if these resources were to be privatized within a biosphere reserve (Preston-Whyte 1996). The approach towards tourism within developed countries is usually positive, and therefore tourism might play an ever-increasing role within Biosphere Reserves of these countries.

2.7.6. South Africa's Biosphere Reserves

South Africa can neither be classified as a developed, nor a developing country. Tourism and conservation do however play a major role within South Africa and continue to provide opportunities for the creation of Biosphere Reserves.

South Africa currently have three biosphere reserves, namely the Kogelberg Biosphere Reserve in the Western Cape Province, West Coast Biosphere Reserve in the Western Cape Province, and recently proclaimed in March 2001 the Waterberg Biosphere Reserve in the Limpopo Province. Other biosphere initiatives in South Africa are in the following areas: Wakkerstroom, Maputoland, Tugela and the Kruger to Canyons. However, considering the rich biodiversity in its national parks and protected areas, South Africa could promote more areas as possible biosphere reserves, especially considering several wilderness areas where humans co-exist with nature.

2.7.7. The Waterberg Biosphere Reserve

On The 23rd March 2001, UNESCO officially proclaimed the Waterberg area: The first Savanna Biosphere Reserve in Southern Africa. The Waterberg Biosphere Reserve includes protected areas like Masebe Nature Reserve, Moepel Farms, Mokolo Dam, Marakele National Park, Lapalala Wilderness and Touchstone Game Ranch. The whole biosphere reserve, previously known as the Waterberg Nature Conservancy, stretch over an area of 150 000 hectares [Northern Province Tourism Board (NPTB), 1999].

Walker (2000) noted that there is no other area within the country with comparable attributes and potential for conservation. The area is unexplored, vast, largely unknown and should meet the growing needs of a certain sector of the tourism industry. However, Walker (2000) further stated that the Waterberg cannot compare with the traditional hotspots of South Africa, and that is should not attempt to do so. It should rather try to retain its own unique blend of wild country with its multi cultural diversity catering for budget as well as international tourists.

According to UNESCO's standard application form for membership to the Waterberg Biosphere Reserve, the primary objectives identified by Limpopo Nature Conservation are as follows:

- Participate in the Man and the Biosphere program of UNESCO
- Generate interest and active participation in environmental conservation amongst all its members
- Conserve and enhance the scenic environment, indigenous fauna and flora and cultural history of the Waterberg mountains
- Implement strategies for the sustainable utilization of the natural and cultural resources of the area
- Improve the quality of life of the people within the Waterberg area through the creation of job opportunities and the execution of education and training programs
- Enhance the tourism potential and tourism information network in the Waterberg area
- Maintain the Biosphere Reserve centre (office) that will provide a local scientific and technical support service to the biosphere reserve members relating to all environmental and tourism issues
- Participate in joint ventures to promote the biosphere reserve on a regional and global scale
- Subject itself to national and provincial legislation and policies relating to environmental issues (NPTB, 1999).

The Limpopo Province Tourism Board Chairperson Charles Maluleke envisaged that the reserve would become an increasingly important component of the Limpopo Province tourism product. He stated that the close proximity of the fascinating Waterberg region to the Gauteng Metropolitan area, absence of malaria and excellent tourism infrastructure already in place, make the region an ideal holiday destination for city dwellers in search of relaxation (Waterberg Newsletter, 2001).

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CHAPTER 3
THE STUDY AREA

3.1 Introduction

The Waterberg Biosphere Reserve lies in the southwest of the Limpopo Province, South Africa and forms part of the savanna biome of southern Africa (Low & Rebelo, 1996). The Reserve was previously known as the Waterberg Conservancy and stretches over an area of about 150 000 hectares (1500km^2) from Thabazimbi in the southwest, through Vaalwater, Melkrivier and Marken, ending northwest of Mokopane in the Wonderkop Nature Reserve (Figure 3.1). The Biosphere Reserve is well conserved in several Private Reserves, National Parks and Nature Reserves as shown in figure 3.2. The rugged beauty of the area, together with it's diversity in plant and animal life, have led to the development of several exciting ecotourism projects, of which the Biosphere Reserve forms an integral part (NPTB, 1999).

3.2 Geology

Geology is directly related to soil types and plant communities that may occur in a specific area (Van Rooyen & Theron, 1996). Jansen (1982) and Callaghan (1987) described the geology of the Waterberg extensively. The main Waterberg basin occupies an area of approximately 22000 km^2. However, the focus of this study encompasses the area of the Waterberg Biosphere Reserve, which includes an area of 1500 km^2 within the main mountain range and the surrounding hills and plains.

The Waterberg group consists mainly of a succession of coarse clastic sedimentary rocks, which shows two upward fining sequences namely the early - and late-Waterberg basins respectively. The sediments show a fining upwards throughout the succession from rudites through arenites to lutaceous arenites (Callaghan, 1987). The beds were deposited in several intracratonic basins on the Transvaal craton. The main Waterberg group rests unconformably on rocks belonging to the Soutpansberg Group, the Rooiberg Group, granites and mafic rocks of the Bushveld Complex (Jansen, 1982). The Waterberg group has been divided into the Nylstroom, Matlabas and Kransberg Subgroups containing in aggregate twelve formations as shown in Table

3.1. The formations are differentially developed and, in several instances, are laterally gradational into one another. The Nylstroom subgroup is confined to the early Waterberg basin. The Matlabas subgroup forms the middle part of the succession in the Main Waterberg basin and the lower part in the late Waterberg basin. The Kransberg subgroup is the uppermost portion of the whole succession (Jansen, 1982). Figure 3.3 shows the distribution of the geological formations within the Waterberg Biosphere Reserve as classified by Jansen (1982). The Waterberg group with its subgroups are of Mokolian Erathem, with ages from 1700 Ma to 1300 Ma (Jansen, 1982). The most common colour of Waterberg sediments is of a mid-red (5R) hue, of medium to low value (relatively dark) and of a low to moderate chroma (poorly to moderately saturated) (Callaghan, 1987).

The plains surrounding the main Waterberg basin towards the north of the Biosphere Reserve and at Thabazimbi in the southwest has been classified by Jansen (1982) as undifferentiated post Waterberg rocks. The geological composition of the plains is however, lava, conglomerate, sandstone, siltstone and greywacke (Geological Survey, 1970).

Table 3.1 Stratigraphic subdivisions of the Waterberg group (Dominant lithology in brackets) (Callaghan, 1987; Jansen, 1982)

<table>
<tr><th>Group</th><th>Subgroup</th><th>South/ Southwest & Central parts</th><th>Southeast & Central parts</th><th>North/ Northeast & Central parts</th><th>Modimolle area</th></tr>
<tr><td rowspan="7">Waterberg Group</td><td rowspan="3">Kransberg</td><td colspan="3">Vaalwater Formation (Sandstone, siltstone, shale)</td><td rowspan="5"></td></tr>
<tr><td colspan="3">Cleremont Formation (Sandstone, Grit)</td></tr>
<tr><td>Sandriviersberg formation (Sandstone, Grit)</td><td>Sandriviersberg/ Mogalakwena formation</td><td>Mogalakwena formation (Sandstone, Grit)</td></tr>
<tr><td rowspan="2">Matlabas</td><td>Aasvoëlkop Formations (Siltstone, mudstone, shale)</td><td>Aasvoëlkop/ Makgabeng Formations</td><td>Makgabeng Formation (Sandstone)</td></tr>
<tr><td>Skilpadkop Formation (Sandstone, conglomerate)</td><td>Skilpadkop Formation</td><td>Setlaole Formation (Sandstone, Conglomerate)</td></tr>
<tr><td rowspan="2">Nylstroom</td><td>Alma Formation (Sandstone, conglomerate)</td><td rowspan="2">Sterkrivier formation (Sandstone, conglomerate)</td><td rowspan="2"></td><td>Alma Formation (Sandstone, conglomerate)</td></tr>
<tr><td>Swaershoek formation (Sandstone, conglomerate)</td><td>Swaershoek formation (Sandstone, conglomerate)</td></tr>
</table>

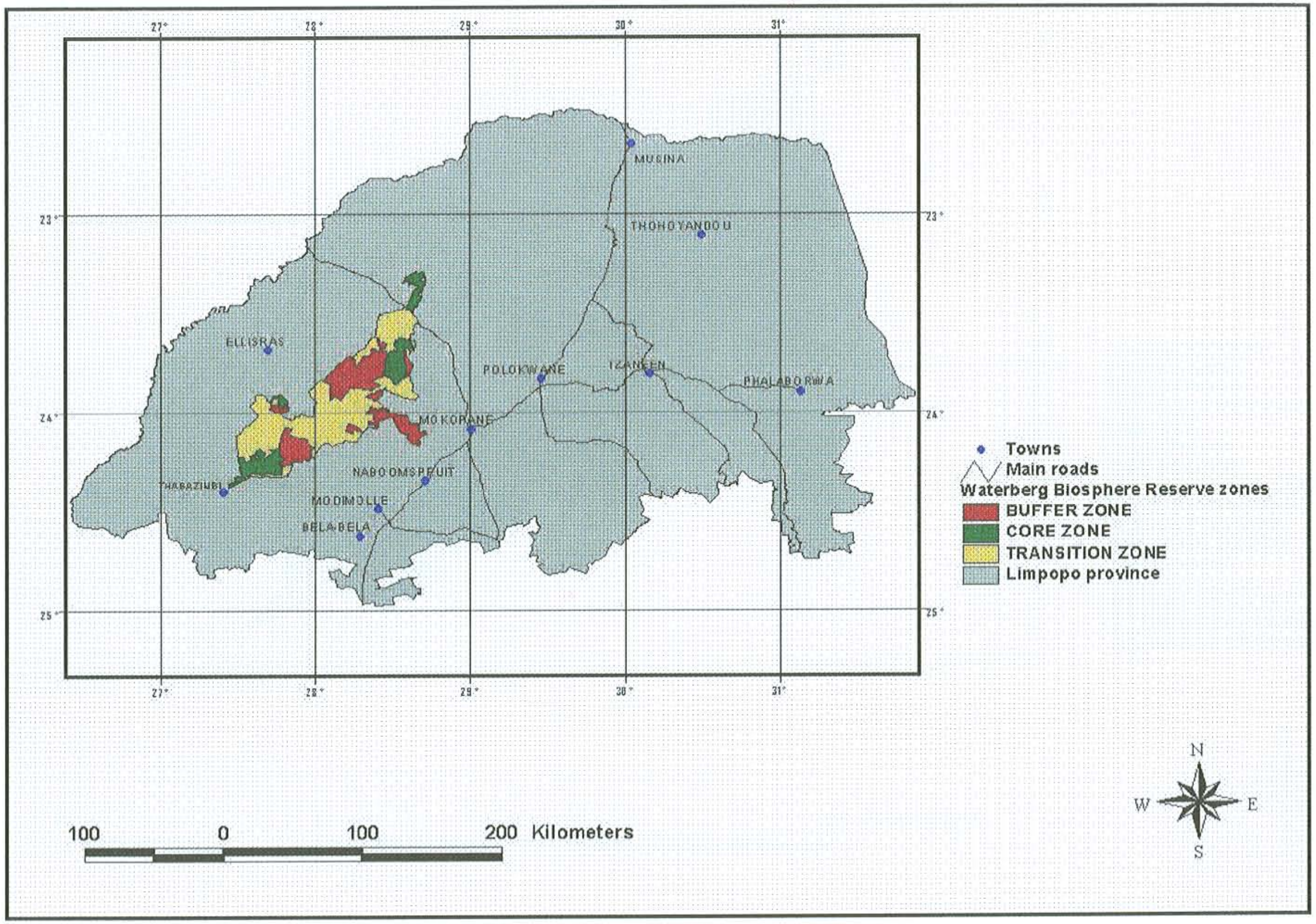

Figure 3.1 Location of the Waterberg Biosphere Reserve within the Limpopo Province, showing the zones within the Biosphere Reserve

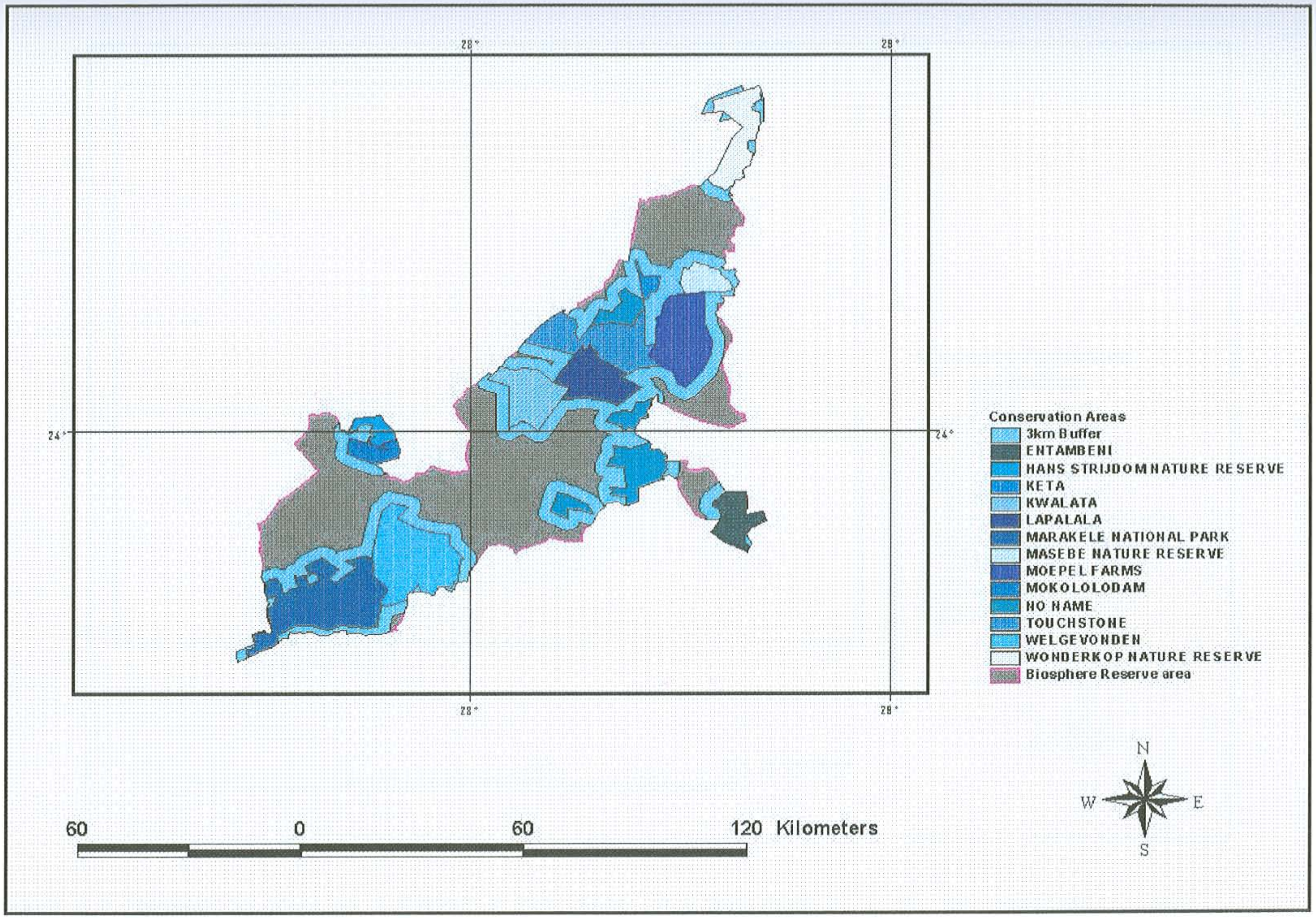

Figure 3.2. Conservation areas in the Waterberg Biosphere Reserve (ENPAT, 2000)

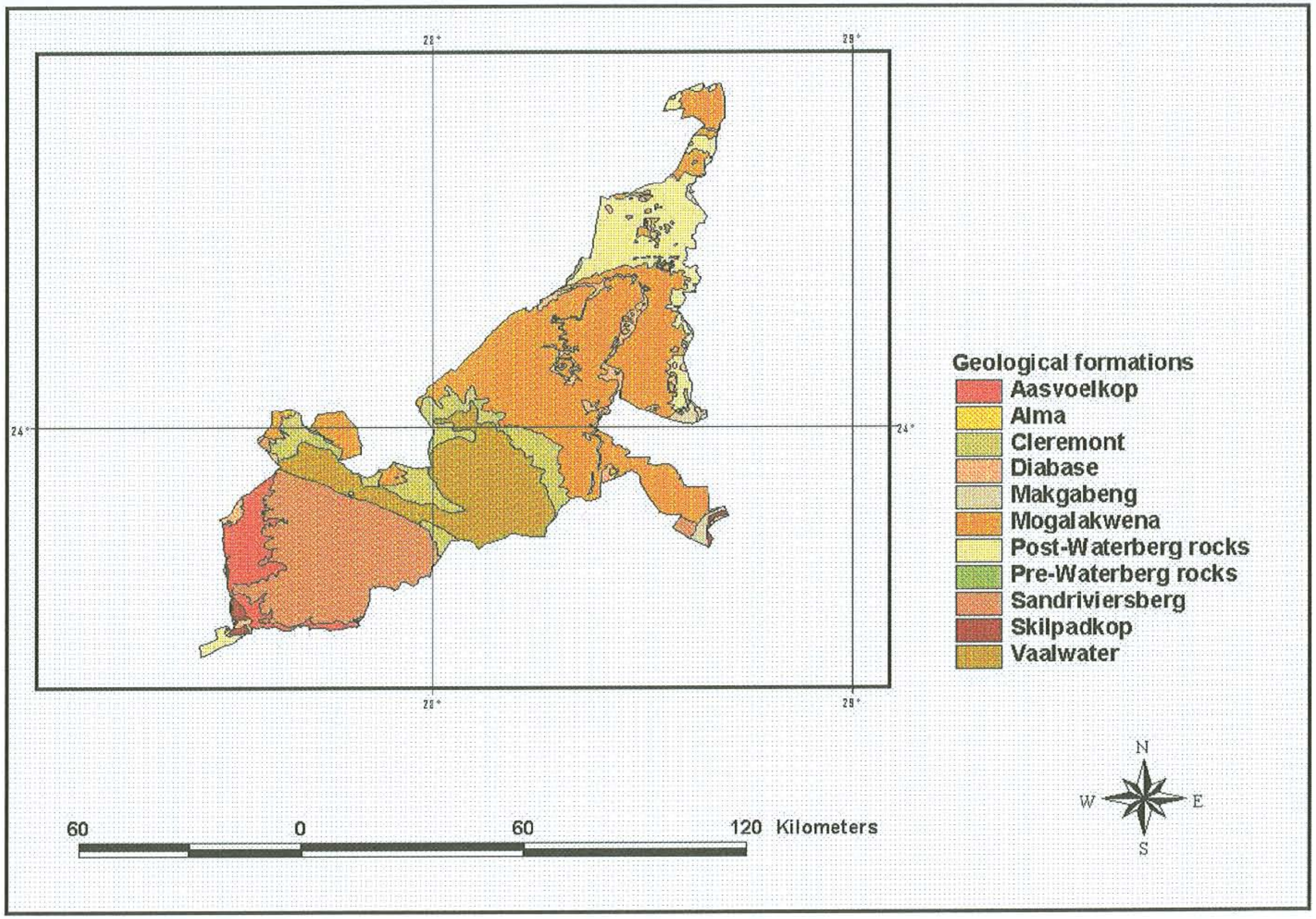

Figure. 3.3. Distribution of the main geological formations in the Waterberg Biosphere Reserve (Jansen, 1982)

3.3 Geomorphology

Geomorphology also plays an important role in determining plant community distribution. Bothma (1996) stated that northern slopes are warmer than south facing slopes in South Africa, and subsequently drier, causing plants to have a higher rate of evapotranspiration. Therefore, plants that are adapted to drier conditions will grow on these slopes. Furthermore, aspects like the degree of slope will also determine the amount of surface runoff after precipitation and direct sunlight having direct effects on water availability and sunlight for plants. The influence of geomorphology on distribution of plant communities is well documented in South Africa (Theron, 1973; Bredenkamp & Theron, 1978; Coetzee, 1983, Gertenbach, 1983).

The surface relief of the Waterberg Plateau is extremely irregular, constituting a great diversity of physical features (Van der Merwe, 1962). The mountainous areas can rise up to an altitude of 2088 m above mean sea level, decreasing in altitude northwards. Extensive plains at altitudes between 800 and 1200m above mean sea level occur in the far north of the study area (Westfall, 1992). The tract of the country is in some sections dissected by numerous deep narrow valleys cut by spruits and in others again there are broad plains above which escarpments of sandstone are prominent features, for example in the Marakele National Park near Thabazimbi. In the intervening sections between these valleys, the country is irregularly hilly with small basins shut in by the hills and possessing an undulating surface relief (Van der Merwe, 1962), as seen in the Vaalwater area. These geomorphological features are presented in figure 3.4.

The Waterberg Plateau is a structural plain that formed when soft sandstone beds above were removed by erosion, so that the upper surface of a hard band was exposed and this today governs the general level of the landscape. The sandstone of the Waterberg plateau is reddish in colour and resistant to weathering. These rocks are powerful escarpment makers, hence the surrounding country is overlooked from the battlemented crests of a series of warmly red precipices. The region is rugged throughout, the surface rough and rocky; but the lower courses of the rivers are broad and open, and often flooded with sand, which has accumulated locally in sufficient

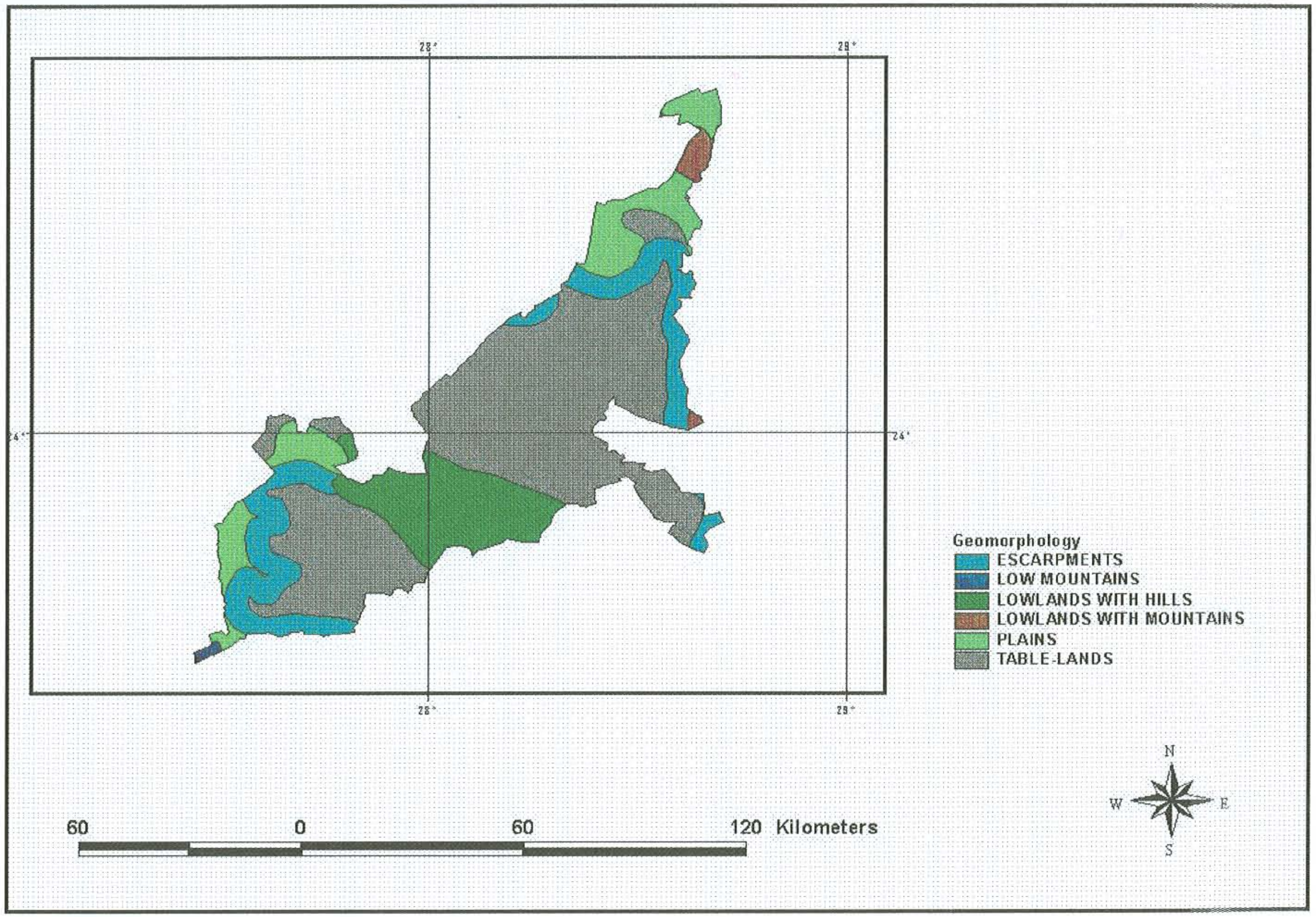

Figure.3.4 Geomorphological formations within the Waterberg Biosphere Reserve (ENPAT, 2000)

quantity to build extensive flats (King, 1951). The rivers, like the Mogol, Palala and Sterk Rivers are mainly perennial and flow northwards to confluence with the Limpopo River. The rivers which rise upon the plateau do so in open drainage basins perched high above the surrounding country to which they descend by splendid falls over the environing cliffs or by way of deep gorges. There are many detached plateau masses and several of them carry the perched drainages and beveling of the "Gondwana" landscape. Some of the masses are clearly faulted and diabase dykes run through the country for miles, their straight courses forcibly with the winding terraced edges of the horizontal strata of sandstone or of shale (King, 1951).

3.4 Soils

Soils and parent material from which it originate, have a great influence on the composition and structure of the vegetation of different areas (Brady & Weil, 1996), and it is therefore important to include soil types during phytosociological studies. The soil and its processes do not constitute an independent system, but rather are a part of the larger ecosystem, which includes vegetation, and its entire environment. The characteristics of a mature profile are partially produced by the vegetation, and their formation is possible only because of the kind of vegetation supported by that soil in a given climate (Oosting, 1956).

The most common soil group in the Savanna biome, accounting for just under 25% of the area in South Africa, is weakly developed soil on rock, closely followed by sands, combinations of black and red clays and solonetzic soils, and generally neutral soils of the red-yellow-grey latosol plinthic catena (Rutherford & Westfall, 1996). These variations in soils occur because of the irregular hilly and mountainous topography (Van der Merwe, 1962). Table 3.3 shows some of the more common soil families identified in the major areas of the Waterberg during previous studies by some of the authors listed in Table 4.1 (Chapter 4). The deeper phase of the soils in the Waterberg was described by Van der Merwe (1962) as a dark brown to light brown, even reddish brown, structureless, brittle sand bound by the roots of plants. These soils are situated on fair slopes and are of colluvial origin. These soils are patchy owing to the hilly surface relief; rugged boulders cover the hills and escarpment and stones with no soil material intermixed.

3.3 Common soil families identified in the Waterberg area during previous studies and their occurrence and characteristics

Soil form	Habitat type	Soil characteristics
Hutton	Mid and footslopes; plains	Depth: 350-1200 mm High pasture potential Red colour
Clovelly	Mid and footslopes; plains	Depth: 350-1200 mm Leached Yellow, sandy
Mispah	Margins of Ridges, koppies; high lying Ravines - Woodland	Depth: 50-150 mm Rocky Leached; erodable Rocky area
Glenrosa	Edges of rocky outcrops; undulating plains	Depth: 200-1000 mm Conglomerate on surface
Cartref	Lower concave slopes	Moderately sandy Depth:
Westleigh	Upper plateaus, south facing lower slopes in open woodland	Depth: 80 - 1000 mm Sandy
Oakleaf	Valley bottoms; along riverbeds	Depth: 1000 - 1500 mm Clay content: 15 - 20%
Rensburg	Close to marsh areas	Depth: As deep as 1000 mm G - Horizon; Clayey
Fernwood	Between slopes and low lying water catchment areas; plain areas	Depth: 1200 mm and deeper
Arcadia	Low lying areas	High clay percentage Depth: < 1000 mm

At the foot of steep slopes and escarpments, angular breccia has accumulated in large heaps, sometimes partly covered by sandy material of variable thickness. These soils have a good surface and internal drainage, with the sand layer resting directly on the parent material (undecomposed rock). The Hutton and Clovelly soil forms are excellent examples of such soils as stated in Table 3.3.

In the low-lying areas where the ground is almost flat or near watercourses draining the area, water accumulates to an appreciable extent because of the high rainfall, the steep topography, and the poor water retaining capacity of the soils on the slopes and their excessive internal drainage. The water draining down the slopes finds fairly impervous strips of soil on either banks of the rivers and spruits behind which it accumulates causing waterlogged conditions. This waterlogging also takes place in the bottom of basins hemmed in by hills. A good example of a soil form stated in Table 3.3 is the Arcadia family (Van der Merwe, 1962).

3.5 Vegetation

The vegetation of the Waterberg Biosphere Reserve falls within the Savanna biome as described by Rutherford & Westfall (1986) and Low & Rebelo (1996). This biome is the largest biome in southern Africa, occupying 46% of its area, and over one third the area of South Africa. A grassy ground layer and upper layer of woody plants characterize it. Where the upper layer is near the ground, the vegetation may be referred to as Shrubveld, where it is dense as Woodland, and the intermediate stages are locally known as Bushveld (Low & Rebelo, 1996). Acocks (1988) and Low & Rebelo (1996) have both described the vegetation types that lie within the Waterberg Biosphere Reserve.

Acocks (1988) described the main vegetation of the Waterberg area as Sour Bushveld (A20), with the 700 km^2 central area between the Matlabas and Mogol Rivers known as Mixed Bushveld (A18). The irregular belt on the gentle slopes to the mountains, between the sour types and the mixed types of the plains and valleys is described as Sourish Mixed Bushveld (A19). A very important and interesting area within the Biosphere Reserve lies towards the southwest. This area was classified by Acocks

(1988) as Northeastern Mountain Sourveld (A8) (Figure 3.5) and include both the forest (ravines) and sourveld variations. This vegetation type occurs on the wetter part of the Kransberg Mountains in the Marakele National Park where rainfall is between 900 and 1950 mm per annum. In the northern part the vegetation is classified as Arid Sweet Bushveld (A14) and occurs in a somewhat drier area, although still being part of the main Waterberg Basin (Jansen, 1982). The distribution of the vegetation types within the Waterberg Biosphere Reserve can be seen in Figure 3.5.

Mainly three vegetation types occur in the Waterberg region as classified by Low & Rebelo (1996). Fire and grazing have been identified as important parameters in the determination of structure in the vegetation types. The vegetation type of the main Waterberg area that occurs within the Biosphere Reserve is mainly known as Waterberg Moist Mountain Bushveld. Aspect plays an important role in the distribution of the plant species in this vegetation type. (Van Rooyen & Bredenkamp, 1996[a]). The Mixed Bushveld vegetation type only occurs as small incursions into the Waterberg Moist Mountain Bushveld. Conserved areas like the Nylsvley Nature Reserve, Ben Alberts Nature Reserve and Mabula Game Lodge are all situated on the transition zone between the Waterberg Moist Mountain Bushveld and the Mixed Bushveld. The vegetation in the Mixed Bushveld vegetation type varies from a dense, short bushveld to a rather open tree savanna. (Van Rooyen & Bredenkamp, 1996[b]). The northern section includes the Sweet Bushveld vegetation type where the lower rainfall and grazing are important determinants of the short and shrubby vegetation structure (Van Rooyen & Bredenkamp, 1996[c])

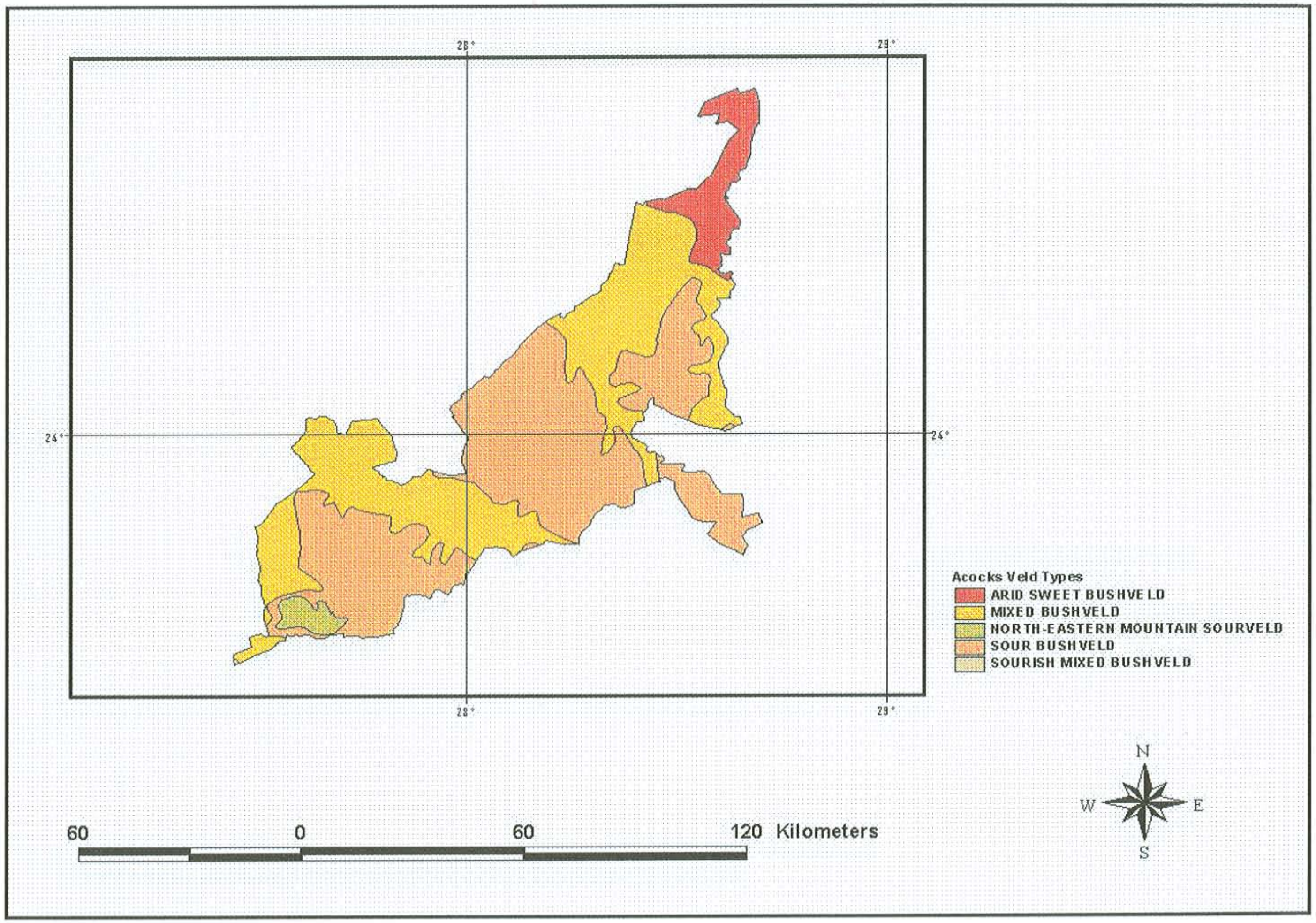

Figure. 3.4 Vegetation types within the Waterberg Biosphere Reserve as classified by Acocks (ENPAT, 2000).

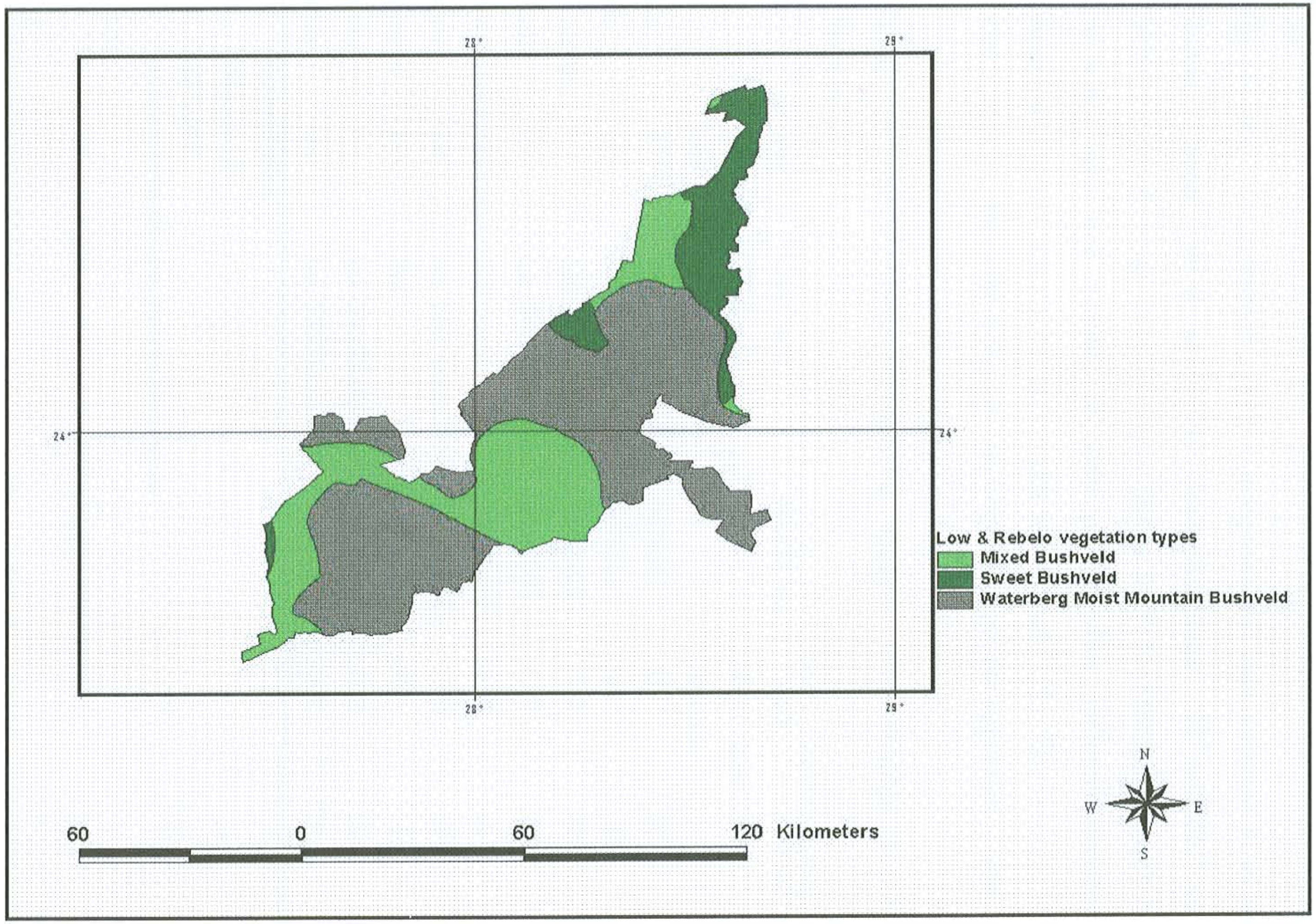

Figure. 3.4 Vegetation types within the Waterberg Biosphere Reserve as classified by Low & Rebelo (ENPAT, 2000).

3.6 Climate

Climate in the broad sense is a major determinant of the geographical distribution of species and vegetation types. However, on a smaller scale, the microclimate, which is greatly influenced by local topography, is also important. Within areas, the local conditions of temperature, light, humidity and moisture vary greatly and it is these factors which play an important role in the production and survival of plants (Tainton, 1981).

The climatic data presented in the following sections were obtained from the Weather Bureau, Pretoria. Data obtained were measured between 1995 and 2000 and included the following: Average monthly temperatures from 4 weather stations in and around the study area and average monthly rainfall from different weather stations, municipalities and other local authorities in the study area. The weather stations and other localities where the different data were obtained are stipulated in Table 3.1.

Table 3.1 Weather Station information obtained from Weather Bureau, Pretoria (Weather Bureau, 2000).

Place	Data obtained from	Coordinates	Station No.	Height above mean sea level	Rainfall data	Temperature data
Ellisras	WS[1]	N/S	0674341 8	839	X	X
Marken	WS	N/S	0675666 2	N/s	X	X
Naboomspruit	P[2]	Lat. 2431 Long.2843	0590361x	1113	X	
Modimolle	M[3]	Lat. 2442 Long.2825	05897325	1173	X	
Mokopane	WS	N/S	0633882 7	1057	X	X
Sterkrivier	N/S[4]	Lat. 2409 Long.2846	0633459 5	1097	X	
Thabazimbi	WS	N/S	0587725cx	977	X	X
Vaalwater	P	Lat. 2418 Long.2807	0632198 1	1215	X	
Villa Nora	N/S	Lat. 2332 Long.2807	0675182 9	844	X	

1. Weather Station
2. Police Station
3. Municipality
4. Not specified on data sheet from Weather Bureau

3.6.1 Rainfall

In terrestrial environments, limitations related to water availability are always important to plants and plant communities. The spatial and temporal distribution of rainfall is very complex and has great effects on the productivity, distribution and life forms of the major terrestrial biomes (Barbour *et al.* 1987). The annual rainfall of the Waterberg Moist Mountain Bushveld varies from 650 to 900 mm (Van Rooyen & Bredenkamp, 1996[a]), but the rainfall is much lower in the Mixed Bushveld and Sweet Bushveld between 350 and 650 mm per annum (Van Rooyen & Bredenkamp, 1996[b,c]), mainly occurring in summer. Aspects like topography, slope and altitude may result in differences in precipitation and water availability to plants within the study area. Figure 3.1 shows the differences in average annual rainfall, and figure 3.2 shows the average monthly rainfall both measured at 9 different sites within the Waterberg Biosphere Reserve and surrounding areas between 1995 and 2000.

The highest annual rainfall within the study area was recorded at Sterkrivier in the eastern part of the Biosphere Reserve near Entabeni Nature Reserve, with an annual average of 680.1 mm. The general trend in annual rainfall was that the central sections near Vaalwater in the main basin showed much higher rainfall than the northern parts (Ellisras, Villa Nora, Mokopane and Marken) which lies in a zone of Mixed Bushveld and Sweet Bushveld. The eastern and western sections showed similar rainfall patterns over the 5 year period, although annual rainfall between weather stations in the eastern section were much more variable, while the western section showed more stable rainfall.

The rainfall season for the Waterberg region stretches between middle October to April, after which it becomes drier, with the driest months being July and August. Figure 3.2 shows the monthly rainfall pattern over the year as an average of the 9 stations monitored. The highest average monthly rainfall occurred in January with a value of 106.9 mm for the month over the 5-year period. It must also be noted that 1996 and 2000 were exceptionally wet years with high, possibly cyclic rainfall occurring at all the stations between January and February.

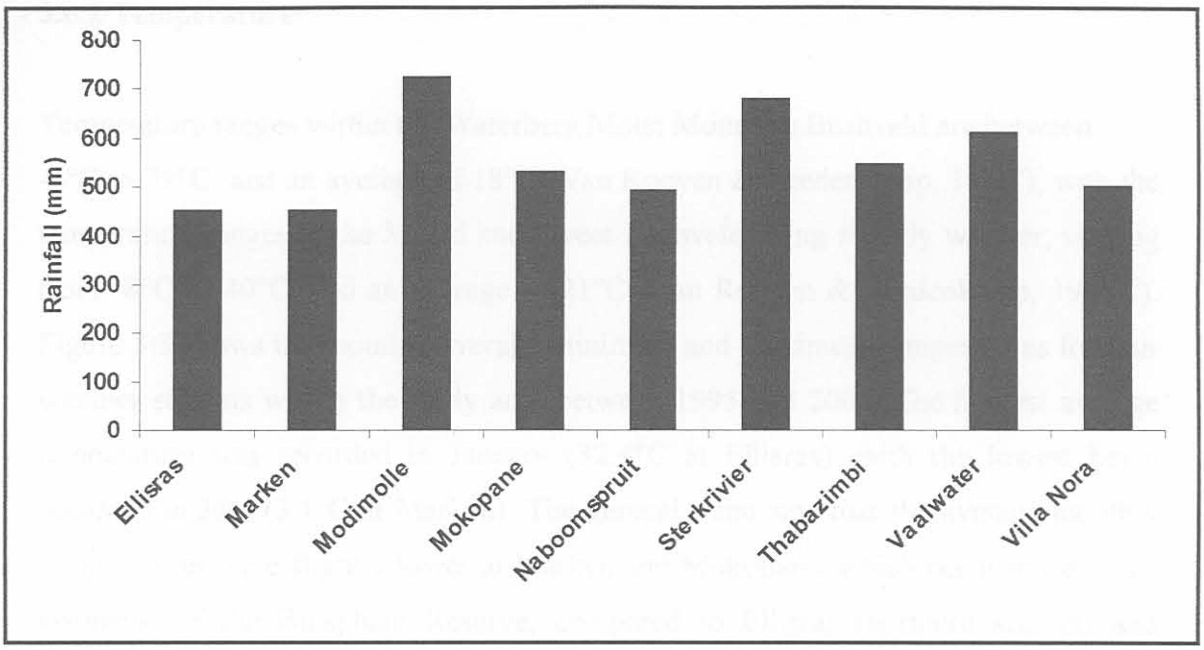

Figure 3.1 Average annual rainfall of different sites within the study area collected between 1995 and 2000 (Weather Bureau, 2000).

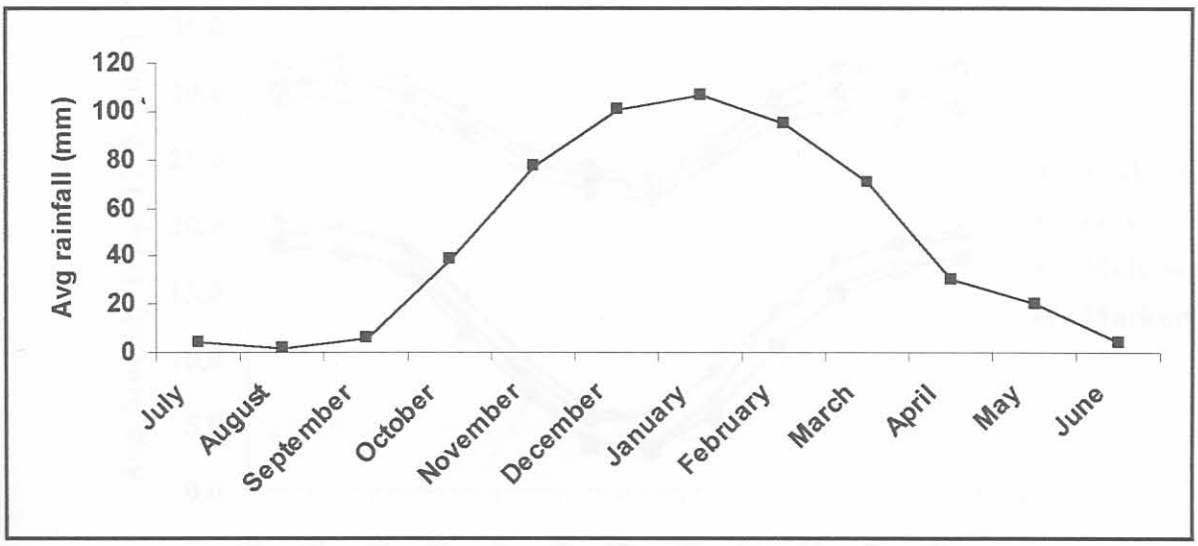

Figure 3.2. Average monthly rainfall of 9 different locations within the study area monitored between 1995 and 2000 (Weather Bureau, 2000).

3.6.2 Temperature

Temperature ranges within the Waterberg Moist Mountain Bushveld are between -6°C to 39°C, and an average of 18°C (Van Rooyen & Bredenkamp, 1996[a]), with the temperature ranges in the Mixed and Sweet Bushveld being slightly warmer, varying from -8°C to 40°C, and an average of 21°C (Van Rooyen & Bredenkamp, 1996[b,c]). Figure 3.3 shows the monthly average minimum and maximum temperatures for four weather stations within the study area between 1995 and 2000. The highest average temperature was recorded in January (32.4°C at Ellisras), with the lowest being recorded in July (3.1°C at Marken). The general trend was that the average monthly temperatures were slightly lower at Marken and Mokopane, which occur more to the northeast of the Biosphere Reserve, compared to Ellisras (northern section) and Thabazimbi (Southwestern section). The drier temperatures in northern section falls within the mixed bushveld and sweet bushveld vegetation types described by Van Rooyen & Bredenkamp, (1996[b,c]).

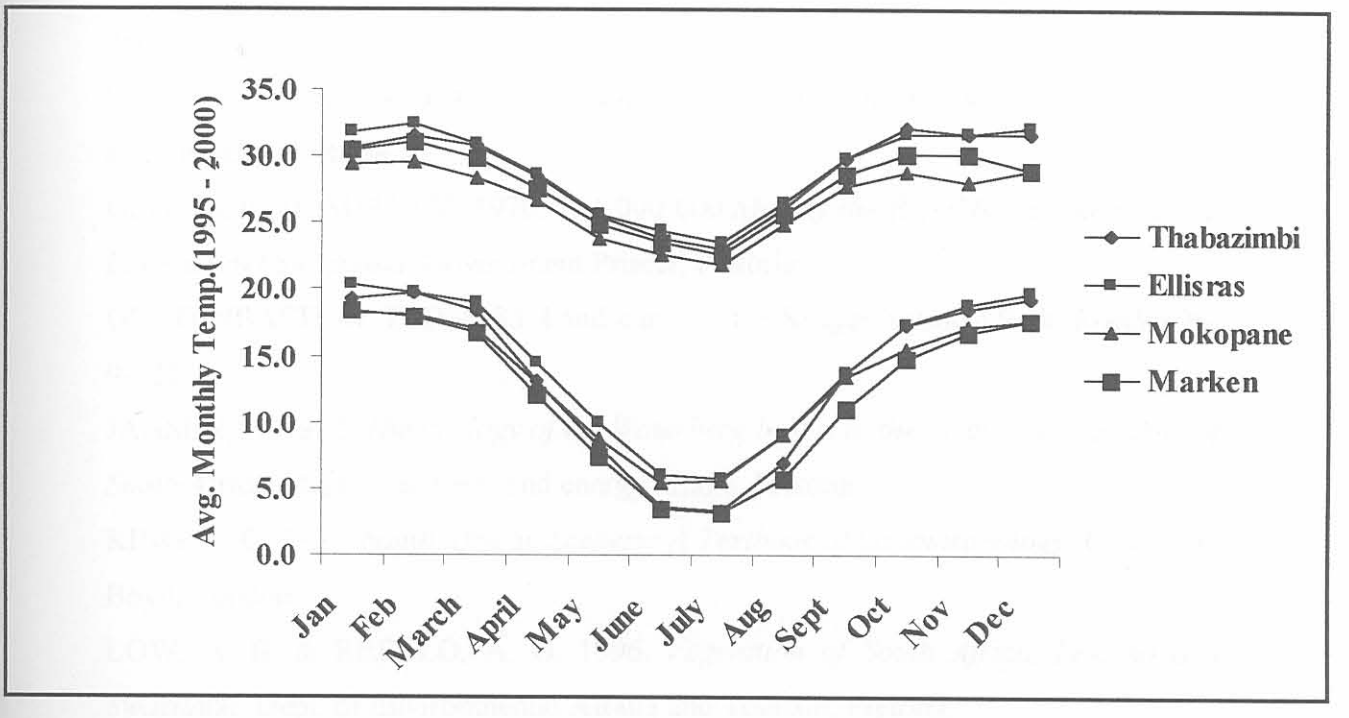

Figure 3.3 Average monthly temperatures of 4 weather stations within the study area.

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CHAPTER 4
CLASSIFICATION OF THE PLANT COMMUNITIES OF THE WATERBERG BIOSPHERE RESERVE

4.1. Introduction

The identification and classification of plant communities within large vegetation types in the South African savanna biome, as classified by Low & Rebelo (1996), have not been done in much detail. Although several studies have been done in the Waterberg area (Westfall, 1981; Newberry, 1998; Van Staden, in prep.), the need to have a more detailed though holistic view of the vegetation has become extremely important after the proclamation of the Waterberg Biosphere Reserve in 2001(Waterberg Newsletter, 2001).

Bredenkamp & Brown (2001) emphasized that the study of plant communities as fundamental units of ecosystems is basic to environmental planning and the compilation of environmental management plans. The identification of the plant communities in the Waterberg Biosphere Reserve might therefore be useful later in environmental management plans, and with the increase in tourism activities in the area, also in the promotion of tourism within the Biosphere Reserve.

The aim of this classification was to identify the major plant communities within the Biosphere Reserve that might provide specific habitats for tourist attractions such as mammals, birds and trees. These plant communities will represent ecohabitats, which combined, form large ecosystems, namely tourism ecozones (see Chapter 5). The level of classification was therefore aimed at identifying large areas within the Biosphere Reserve, which are relatively homogenous in terms of vegetation composition, and still represent plant communities.

4.2. Methods

4.2.1. Introduction

Bredenkamp & Bezuidenhout (1995) and Van der Maarel *et al.* (1987) described methodology used to classify large vegetation data sets. Winterbach (1998) and Du Plessis (2001) have successfully shown the how valuable these methods can be in the classification of large data sets in southern Africa. The following section provides a description of the methodology used in the classification procedures.

4.2.2. Data collection

Braun Blanquet data and descriptions of plant communities within phytosociological studies conducted by authors within the Biosphere Reserve, and in similar adjacent areas, were used for the creation of a database. Data consisted of unpublished and published data from B.Sc. Honors projects, M.Sc., Ph.D. studies and industry reports (Table 4.1). The locations where the studies were performed were visited and visual assessments were done to ensure the data sets were of an efficient standard to be included in the classification. Other studies included were data from floristic assessments for Ecological Management Plans performed by companies in the ecological field. However, although several studies have been conducted in the Waterberg Biosphere Reserve, in certain areas no data existed, and therefore field studies needed be done.

4.2.3 Field Surveys

Field surveys were performed within the Waterberg Biosphere Reserve in areas where data was found inadequate or not existing. These surveys in so-called "gaps" were done using standard Braun - Blanquet vegetation survey methods (Westhoff & Van der Maarel, 1982), using cover-abundance values given by Werger (1974). The areas in which the field surveys were performed are included in Table 4.1. It includes 58 relevés from the Wonderkop Nature Reserve, Masebe Nature Reserve, the Kwaggasvlakte plains at Marakele National Park and the vlei area in the Nylsvley Nature Reserve.

4.2.4. Database

After the data collected were found to be representative of the Waterberg Biosphere Reserve, a database was created on a vegetation database computer program, TURBOVEG (Hennekens, 1996[a]). A total number of 1419 relevés from 19 data sets were combined in the database file. The 58 additional relevés obtained from the field surveys were added to the original database. The data from the TURBOVEG database was classified using TWINSPAN (Hill, 1979), and refined by using Braun-Blanquet procedures in the programme MEGATAB (Hennekens, 1996[b]). The final classification consisted of 1477 relevés in total. Within each relevé, specific habitat data like altitude, soil type, geology, which plant community it belonged to in the original data set and vegetation structure were added as extra comments in TURBOVEG. This habitat data proved to be extremely useful during the identification of the vegetation types during classification. The authors, study areas and number of relevés used from each database are summarized in Table 4.1.

Table 4.1 Phytosociological datasets included in the TURBOVEG database of the Waterberg Biosphere Reserve vegetation

Author	Year		No. of Relevès
Botha	1991	Waterberg Game Centre, Melkrivier	59
Bredenkamp	1989	Touchstone Gale Lodge, Melkrivier	12
Brown & Bredenkamp	1999	Shambala Private Nature Reserve, Vaalwater	89
Brown (Ekotrust project)	2002	Kudu Canyon Game Lodge, Vaalwater	15
Centre for Wildlife Management, U.P	1991	Keta Private Nature Reserve, Marken	22
Coetzee et al.	1976	Nylsvley Nature Reserve, Modimolle	207
Du Plessis	1996	Duikerspan, Thabazimbi	17
Du Toit	1998	Entabeni Game Reserve, Sterkrivier	48
Field survey - present study	2002	Masebe Nature Reserve, Marken	16
Field survey - present study	2002	Wonderkop Nature Reserve, Steilloopbrug	27
Field survey - present study	2002	Nylsvley Nature Reserve (Vlei area)	3
Field survey - present study	2002	Marakele National Park (Plains)	10
Fourie	1994	Kwalata Game Ranch, Melkrivier	65
Furniss	1998	Emaweni Game Lodge, Melkrivier	82
Joubert	1998	Sambane Game Lodge	58
Kellerman & Steenkamp	1999	Nua Ranch, Melkrivier	36
Newberry	1998	Entabeni Game Reserve, Sterkrivier	67
Schmidt	1992	Rhino Ranch, Ellisras	46
Smit	1989	Lapalala, Melkrivier	82
Tuinder	1991	Waterberg Game Centre, Melkrivier	46
Turner	1991	Mokolo River Nature Reserve, Vaalwater	85
Van Rooyen & Bredenkamp	1999	Suikerboschplaat farm, Vaalwater	68
Van Staden	In prep.	Marakele National Park, Thabazimbi	130
Von Holdt	1995	Slangkuil Ranch, Vaalwater	48
Westfall	1981	Groothoek, Thabazimbi	170

4.2.5. Classification

The methods proposed for the classification of large datasets by Bredenkamp & Bezuidenhout (1995) and Van der Maarel *et al.* (1987) applies well to classification of large data sets, especially on a syntaxonomic level. For the aim of this study, similar steps were followed from the two-step method proposed by Van der Maarel *et al.* (1987). However, after initial classification certain closely related groups divided by TWINSPAN (Hill, 1979) were united together for the purpose of the identification of the tourism ecozones described in Chapter 5. An example is the sandy patches in between rocky areas on plateaus, terraces and footslopes. The vegetation composition was found to be related to those of the rocky terraces, plateaus and foothills described later in the chapter and therefore form geographically associated habitat types. The plant communities of the Biosphere Reserve described in this chapter will form the socalled "mosaic blocks" from which the ecozones (large, homogenous landscapes) will be identified in Chapter 5. The plant communities thus form part of a larger scale homogenous landscape. For the classification procedure the following steps were followed:

- The database in TURBOVEG was exported as a Cornell Condensed Species file (cc - file) to a directory created in MEGATAB (Hennekens, 1996[b]).
- The file was opened in MEGATAB as a table, and the 1477 relevés were classified by using a Two-Way-Species -Indicator-Analysis (TWINSPAN) (Hill, 1979). In TWINSPAN the following parameters were used during classification:
  - ◊ Cutlevels for cover abundance: 0 - 2 - 10 - 25 - 50
  - ◊ Maximum level of divisions: 3
  - ◊ Other parameters were left default although the option to visualize the cluster hierarchy was selected
- The first classification revealed 7 groups and after a closer investigation of the different groups, further refinement was applied. Certain groups were again subjected to a TWINSPAN classification procedure as stated above, using the same cutlevels but different levels of divisions as follows:
  - ◊ Group 1 represented all freshwater wetlands and was given 1 level of division to separate sponges and vleilands.

  - ◊ Group 3 represented all the mountainous areas and was divided into 4 groups, using 2 maximum level of divisions. The group representing the rocky footslopes, terraces and plateaus was then combined with a similar sandy habitat, since these sandy habitats only represent patchy areas in between rocky areas. This revealed 3 three major habitat types according to plant communities: 1) Steep rocky slopes; 2) footslopes, terraces and plateaus; and 3) cooler higher areas and southern slopes.
  - ◊ Group 4 was given 2 levels of divisions and revealed 3 different groups, namely 1) deep sandy areas, 2) old fields and 3) diabase- and dolerite dykes.

- A dendrogram was constructed from the TWINSPAN table to indicate the levels of division between the different vegetation type and show possible relationships.
- After the 12 groups were obtained, a synoptic table was created in MEGATAB as an option from TWINSPAN, and further refinement was done to cluster species groups together. Clusters were analyzed separately for species frequency values and characteristic species of a cluster were moved to the top. Species with a frequency value of less than 10% were ignored when species groups were formed, and discarded to the bottom of the table, except if such species was known to be an excellent indicator character species of the vegetation type (for example *Erica drakensbergensis* in the high mountainous vegetation type). Further refinement was done using Braun - Blanquet procedures. These procedures revealed 60 species groups with a total number of 1563 species.
- The fully formatted synoptic table was then exported to Microsoft Excel where it was opened. The species group at the bottom of the table, representing species with frequency values of less than 10%, was discarded which further refined the synoptic table to 59 species groups with 496 species. (Table 4.2).

After the classification, the 12 major plant communities were described according to species composition and habitat characteristics. These species compositions within plant communities better express their relationship with one another and environment than any other characteristic (Adriani & Van der Maarel, 1978).

4.3 Results and Discussion

4.3.1 Classification hierarchy

The cluster hierarchy showed by the TWINSPAN result was found quite useful to describe close relationships between clusters and provide an easier understanding of the division of vegetation groups (Du Plessis, 2001). The cluster hierarchy is shown in Figure 4.1.

- The vegetation of the Waterberg Biosphere Reserve was divided on a first level into two main groups. The first group is vegetation associated with the main Waterberg basin underlain by Waterberg Sandstone (Callaghan, 1987), while the second group consist of vegetation associated with marginal areas around the main basin, underlain by different Pre - and Post Waterbergrocks as classified by Jansen (1982). This level of division represents mostly represents the Sour Bushveld and Sourish Mixed Bushveld on the one hand, and the Arid Sweet Bushveld on the other (Acocks, 1988).
- The vegetation associated with the sweet vegetation group is divided on a second level into two groups, which consist of a group of vegetation associated with vertic clay soils,
- while the other group was divided on a third level into the arid sweet plains in the western and dry northern areas, and the termitaria vegetation that sometimes occur in clayey soils overlain by sand.
- The vegetation of the main basin was divided on a second level into vegetation associated with wet or moist areas and vegetation associated with drier areas.
- The moist areas group is divided on a third level into moist kloof areas and wetlands,
- while the wetlands divided on a fourth level into spongy marshes and vleiland areas.
- The drier areas, more common in the Waterberg is divided on a third level into rocky, rugged areas and more low-lying bottomlands.

- The rugged areas are divided on a fourth level into the higher parts of the escarpment and cool southern slopes, and the warmer northern and western slopes, including the higher parts of undulating plains.
- The warmer slopes are divided on a fifth level into steep rocky slopes that dominate most of the mountainous areas, and the rocky footslopes, hills and terraces, including the higher undulating plain areas. These two plant communities are closely related since rockiness would often determine species composition in the mountainous areas (Westfall, 1981).
- The other group of the drier areas is divided on a fourth level into sandy areas and sweet vegetation associated with diabase and dolerite dykes, as well as arid sweet mountainous vegetation on Waterberg Sandstone in the northern Biosphere Reserve.
- The sandy areas is further divided on a fifth level into the low-lying deep sandy areas, seepage lines and sandy plateaus, dominated by *Terminalia sericea* and *Eragrostis pallens*, and the old cultivated fields. The old fields and deep sandy areas are related since the old fields were cultivated on the same low-lying sandy areas where the deep sand vegetation type occurs currently, many years ago. The possible relatedness of the sweet dyke vegetation to the sandy areas could be due to the sandy areas forming a mosaic with the low-lying dykes, the same as previously stated by Winterbach (1998) for the *Terminalio sericeae-Combretetea apiculati* and *Panico maximi-Acacietea tortilis* classes.

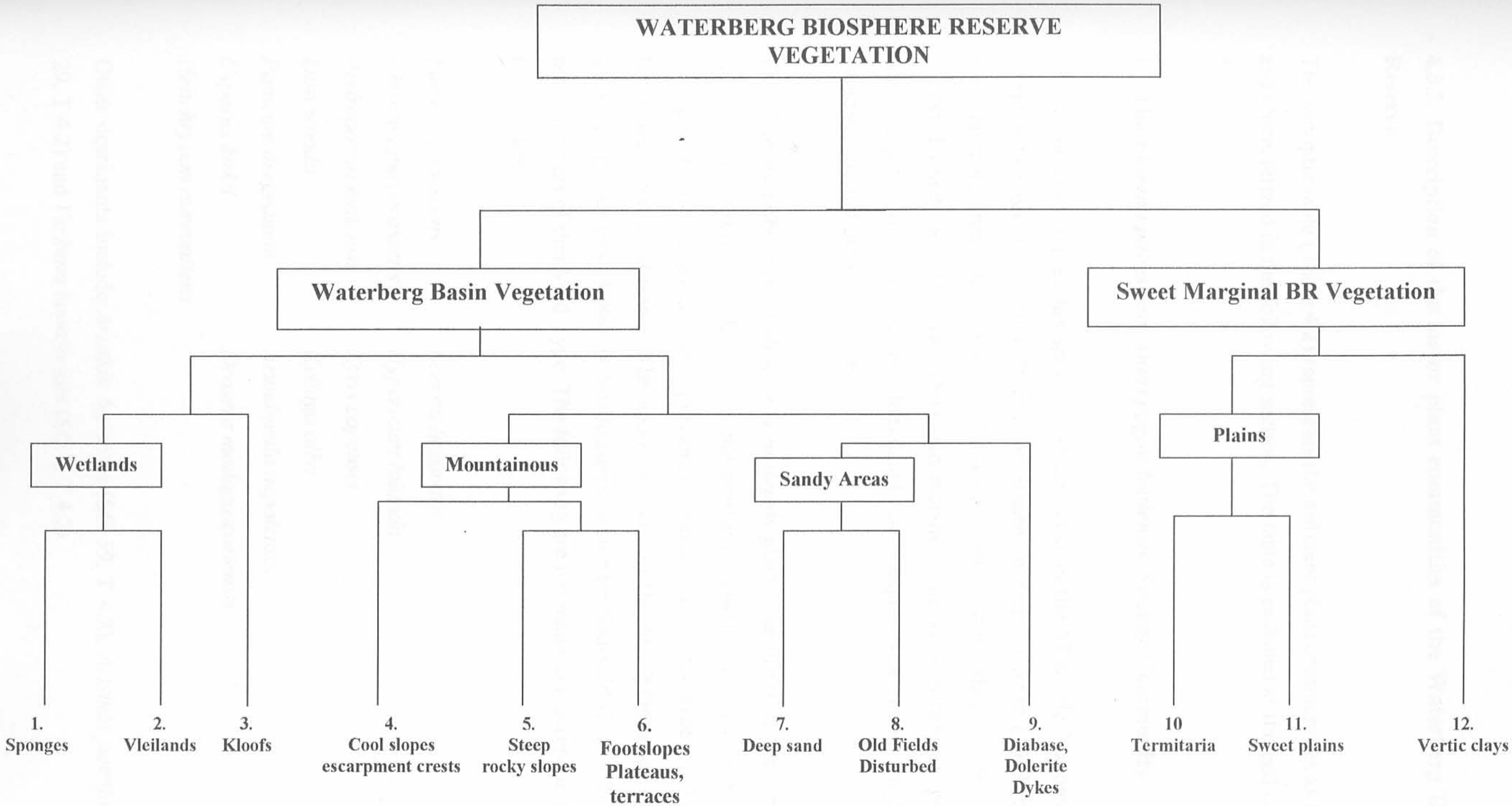

Figure 4.1 Dendrogram showing the hierarchy of the major plant communities of the Waterberg Biosphere Reserve (BR - Biosphere Reserve)

4.3.2. Description of the major plant communities of the Waterberg Biosphere Reserve

The synoptic table (Table 4.2) represents the different plant communities as described and characterized in the following section. The table is included at the end of Chapter 4.

1. The *Fuirena pubescens-Andropogon huilensis* Sponge Community

This community represents sponges, which occur in the Marakele National Park at altitudes between 1300 and 1420 m (Van Staden, in prep.). Cowan (1995) noted that the Waterberg area is known for it's seeps and small reed marshes. Noble & Hemens (1978) defined these shallow submerged marshy areas as seasonally or perennially waterlogged, with vegetation dominated by sedges and other hygrophilous angiosperms and perhaps mosses.

The ***Fuirena pubescens-Andropogon huilensis*** plant community is characterized by species group (SG) 1, Table (T) 4.2, and mostly include herbaceous waterplants and wet grassland species as also previously described by Coetzee (1975) in the Rustenburg Nature Reserve. The sponges occur in the low-lying areas of an area classified by Acocks (1988) as Northeastern Mountain Sourveld (Fig. 4.2), although not being part of this Veld Type. The following are the major characteristic species of the sponges:

Fuirena pubescens	*Leersia hexandra*
Chironia purperascens	*Hypericum lalandii*
Andropogon huilensis	*Xyris capensis*
Disa woodii	*Kylinga alba*
Panicum dregeanum	*Arundinella nepalensis*
Cyperus kirkii	*Drosera madagascariensis*
Helichrysum aureonitens	

Other dominants include *Aristida bipartita* (SG 59, T 4.2), *Aristida junciformis* (SG 29, T 4.2) and *Verbena bonariensis* (SG 3, T 4.2).

These sponges are the sources from where many streams and rivers arise (Noble & Hemens 1978). Van Staden (in prep.) described this community as the *Andropogon huilensis-Xyris capensis* major community occurring along streams and tributaries of the Matlabas-, Mamba and Sterkstroom Rivers. The plant community occurs on Avalon, Katspruit, Oakleaf and Westleigh soil forms, derived from sandstone of the Sandriviersberg formation (Van Staden, in prep). Figure 4.2 shows the sponges occurring in the Marakele National Park, Limpopo Province.

2. The *Phragmites australis-Persicaria serrulata* vlei community

This community represents vlei areas and floodplains which occur in the Nylsvley Nature Reserve and Emaweni Game Lodge. Cowan (1995) desribed this vegetation type as part of riverine floodplains under temporary riverine fresh water wetlands. These wetlands may occur on riverine floodplains, which include river flats, flooded river basins and seasonally flooded grasslands. Bloem *et al.* (1993) described a similar vegetation type as *Phragmites australis* vlei in the Verlorenvallei Nature Reserve on the Highveld, although the *Echinochloa holubii-Cyperus longus* wetland described by Kooij *et al.* (1991) from the western Free State, which is associated with permanent or seasonally wet watercourses, riverbanks, valley flats, flood plains and stream channels, is also closely related to this plant community. Various other authors also described *Phragmites australis* communities in different parts of South Africa, which indicated that it occurs quite widespread in different locations.

The characteristic species for this vegetation type are the typically water-associated species *Phragmites australis, Persicaria serrulata, Potamogeton* species, *Centella* species and *Juncus dregeanus* (SG 2, T 4.2). Other dominant species that occur are species of the Cyperaceae, *Verbena bonariensis* (SG 3, T 4.2), *Bulbostylis burchellii* (SG 22, T 4.2), *Senecio incornatus* and *Setaria incrassata* (SG 58, T 4.2).

This plant community type occurs in a wet zone of 500 mm and sometimes deeper (Bloem *et al.* 1993). Soil types on which this vegetation type occurs include the Katspruit form, Oakleaf form and Valsrivier form, mostly clayey soils as deep as 1 200 mm (Macvicar 1991).

The affinity that species like *Setaria incrassata,* and *Senecio incornatus* (SG 64, T 4.2) have with the plant community described on vertic clay soils in the adjacent area of the Nylsvley Nature Reserve, emphasize a problem encountered during classification of large datasets, namely intrazonal relevés occurring within original datasets. Bredenkamp & Bezuidenhout (1995) stated that intrazonal relevés should be excluded from a large data set before classification. However, the purpose of the study was not primarily to classify vegetation on a syntaxonomic level, rather to identify plant communities as probable habitat types for birds and mammals (Chapters 7, 8). Coetzee *et al.* (1976) classified the floodplain area at Nylsvley as the *Acacia nilotica-Acacia tortilis* variation of *Panicum maximum-Acacia tortilis* communities occurring on flat bottomlands and termitaria. However, during field surveys it was found that this variation rather occurs on a zone next to the main floodplain. Biggs (1979) showed in the Okavango Delta, Botswana, that floodplains should rather be divided into floodplain vegetation types (primary, secondary and grassland communities), marginal vegetation types and dryland vegetation types according to certain species that occur in these zones.

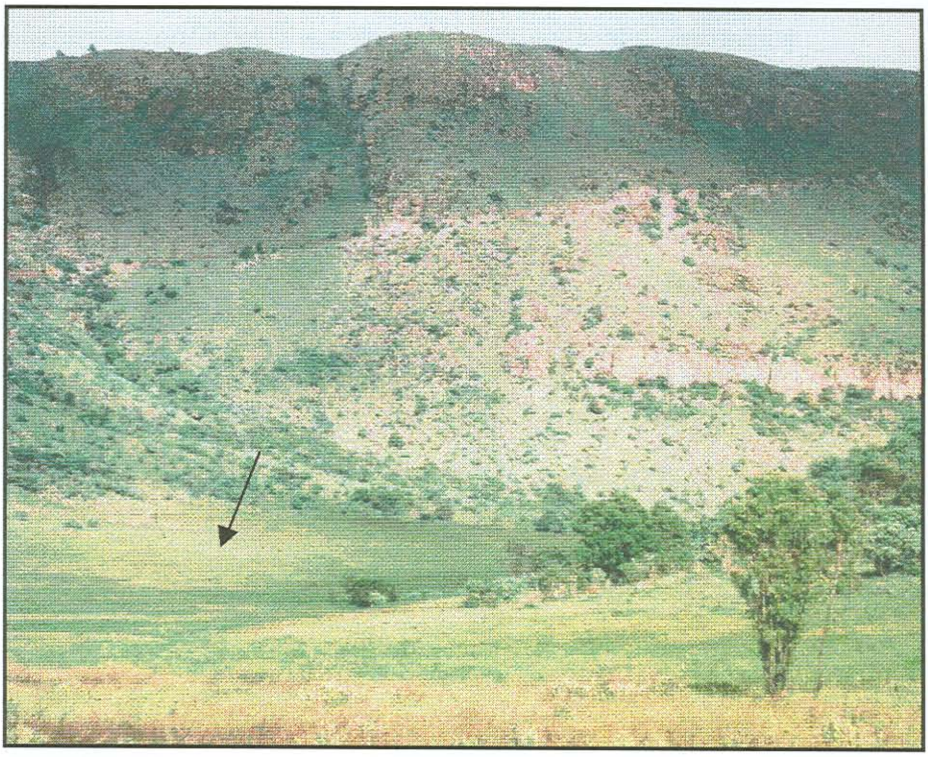

Figure 4.2 The *Fuirena pubescens-Andropogon huilensis* sponge community occurring in the Marakele National Park (arrow)

Figure 4.3. The *Phragmites australis-Persicaria serrulata* vlei community in the Nylsvlei Nature Reserve, showing *Phragmites australis* as a dominant species (arrow)

3. The *Podocarpus latifolius-Diospyros whyteana* Kloof Community

This major plant community is represented in the Marakele National Park, the Farm Groothoek and on the Shambala Private Nature Reserve within the Biosphere Reserve. Acocks (1988) described this plant community type as inland tropical forests, under the Northeastern Mountain Sourveld (A8) Veld Type. It represents the inland, isolated patches of Afromontane forests, although the open warm ravines described by Van Staden (in prep.) are also included. Several studies and floristic descriptions have been done on this Veld Type within different mountain ranges of South Africa (Cooper, 1982, Du Preez *et al.* 1991, Du Preez & Bredenkamp, 1991). Large tree species dominate within the forest ravines and the more prominent characteristic tree species are the following (SG 4, T 4.2):

Podocarpus latifolius	*Widdringtonia nodiflora*
Celtis africana	*Clutia pulchella*
Syzygium cordatum	*Syzygium guineense*
Curtisia dentata	*Ficus sur*
Ilex mitis	*Vepris lanceolata*

Other dominant woody species include *Diospyros whyteana, Olea europaea, Olea capensis* and *Ficus thoningii* (SG 36, T 4.2). Smaller trees or shrubs prominent and characteristic of this vegetation type include *Calpurnia aurea, Pterocelastrus echinatus, Osyris lanceolata, Ochna holstii, Grewia occidentalis, Acokanthera oppositifolia, Rothmannia capensis, Dovyalis zeyheri, Cussonia spicata, Canthium gilfillani* and *Cliffortia linearifolius* (SG 4, T 4.2). Herbaceous species and grasses occur patchy in the undergrowth due to the little sunlight penetrating the canopy. Some of these characteristic species include the fern *Blechnum attenuatum* and *Solanum giganteum, Setaria megaphylla, Ischaemum fasciculatum, Asparagus virgatus* and *Cyperus albostriatus* (SG 4, T 4.2). Other conspicuous species in the undergrowth include the fern *Pteridium aqulinium* (SG 7, T 4.2) and *Asparagus setaceus* (SG 44, T 4.2).

Characteristic species like *Buxus macowani* and *Kirkia wilmsii* (SG 4, T 4.2), and other species like *Olea europaea* subsp. *africana* (SG 36, T 4.2), *Rhus leptodictya* and

Pappea capensis (SG 44, T 4.2) represent the *Buxus macowanii-Kirkia wilmsii* low forest of warmer, drier and more open ravines in the Marakele National Park (Van Staden, in prep.).

The ravines within which this vegetation type occur were formed by the relatively rapid weathering of dolerite dykes within the sandstone (Groenewald, 1986). Soils within the ravines are mostly shallow Mispah form (<500mm), originating from sandstone of the Sandriviersberg formation. During the wet season (October to April; see description of study area), the water seeps through the sandstone forming the sides of ravines creating an ideal moist, sheltered habitat for the forest related species like *Podocarpus latifolius* to grow. Coetzee *et al.* (1981) stated that the ravine forests of the Sour Bushveld within the Kransberg range of the Waterberg vary according to temperature and soil water regime. There are for example dry warm (as described in previous paragraph), humid-warm, dry cool and humid-cool combinations (Van der Meulen, 1979). Du Preez *et al.* (1991) classified the afromontane forests of the Free State Province into two orders of the class *Scolopietea mundii*, namely the order *Podocarpetalia latifolii* and order *Pittosporetalea viridiflorum*. Figure 4.4 show a typical kloof community in the Kransberg Mountains in the Marakele National Park.

The first order, the *Podocarpetalia latifolii* (Du Preez *et al.* 1991) represent the moist afromontane communities, similarly described by Van Staden (in prep.) as the *Podocarpus latifolius-Widdringtonia nodiflora* or *Podocarpus latifolius-Rothmannia capensis* short forest, and by Westfall (1981) as *Celtis africana-Asplenium splendens* kloof forest within the study area. These forests occur at cooler, higher altitudes between 1400 and 1800 m above sea level. The rainfall at these altitudes are also considerably higher compared to lower altitudes of the same area (Acocks, 1988).

The *Pittosporetalea viridiflorum* order (Du Preez & Bredenkamp, 1991) occurs in the warmer, yet moist, western habitats of the Drakensberg range in the Eastern Orange Free State, South Africa. Similar, humid-warm kloof communities were described by Westfall (1981) (*Celtis africana-Erythrina lysistemon* kloof forest) and Van Staden (in prep.) (*Olea europaea-Calpurnea aurea* tall closed woodland) in the lower lying ravines of the Waterberg below 1200 m above sea level (Westfall, 1981).

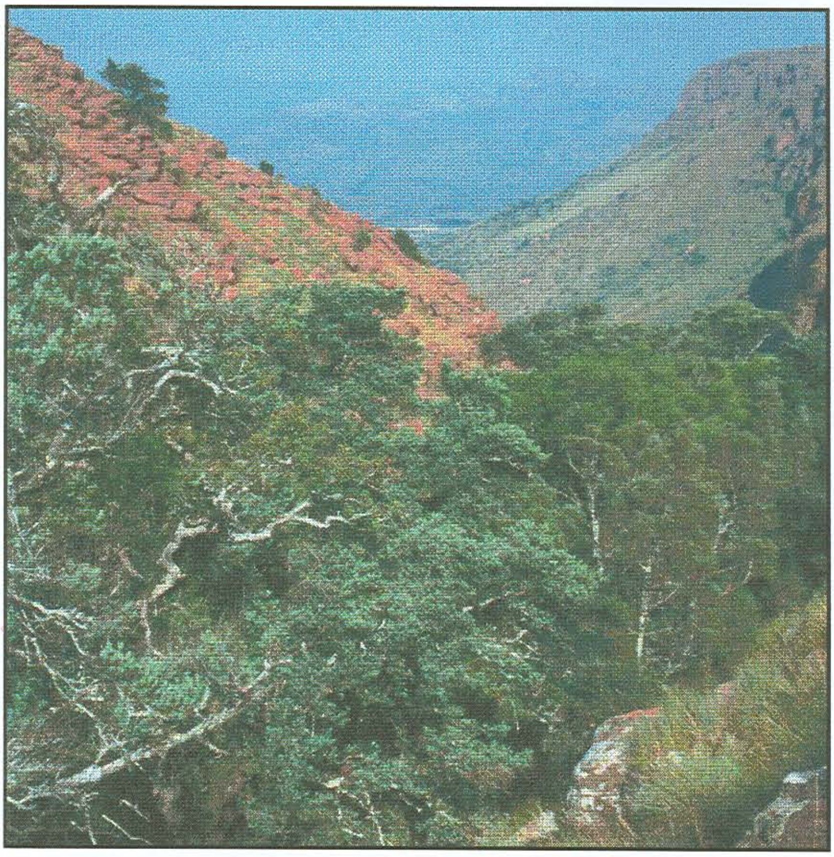

Figure 4.4 The *Podocarpus latifolius-Diospyros whyteana* kloof community occur in moist areas on the escarpment within the Marakele National Park.

4. The *Protea caffra-Loudetia simplex* Cool Slopes and Escarpment Crest Community

The higher part of the Waterberg mountain range, especially along the escarpment (well represented in the Marakele National Park, Groothoek farm, Suikerboshplaat Game farm and Entabeni Game Reserve), as well as the cool, protected southern slopes of other parts of the Waterberg mountain range (Emaweni Game Lodge, Shambala Private Game reserve) includes this plant community. Similar vegetation communities have been described in other localities which include high mountainous parts and southern slopes, such as the Magaliesberg Mountain range in the Rustenburg Nature Reserve (Coetzee *et al.* 1995), Jack Scott Nature Reserve (Coetzee, 1972) (Skurweberg near Magaliesburg), Suikerbosrand Nature Reserve (Bredenkamp, 1975) and the Eastern Transvaal Escarpment (Matthews *et al.* 1991). The vegetation type falls under the sourveld variation of Acock's (1988) Northeastern Mountain Sourveld (A8). Acocks (1988) describes this sourveld as a strongly sour *Themeda*-dominated veld, which replaces the forests, described in the previous section. It was stated that sometimes the breakdown of forest into grassveld or thornveld has never been completed, leaving dense thickets or bushclumps on the exposed, slopes (Acocks, 1988), as described by Van Staden (in prep.) and Matthews *et al.* (1991).

This cool environment has few woody species, although small trees and shrubs like *Protea roupelliae, Rhus magalismontana* and, *Passerina montana* are diagnostic (SG 6, Table 4.2). Other dominant woody species in this vegetation type include *Protea caffra, Rhus dentata* (SG 15, T 4.2), *Vangueria infausta, Englerophytum magalismontanum, Combretum molle* and *Acacia caffra* SG 36, T 4.2). Several herbaceous and forb species are characteristic of this vegetation type. Some of the more dominant species are as follows (SG 6, T 4.2):

Coleochloa setifera	*Berkheya carlinopsis*
Helichrysum nudifolium	*Acalypha angustata*
Anthospermum hispidula	*Polygala hottentotta*
Vernonia galpinii	*Indigofera hedyantha*
Aeschynomene rehmannii	*Thesium utile*

This community includes different structures and variations, due to the varying aspect, slope, altitude and soil types. Coetzee *et al.* (1975) identified the major community of the mountain crests in Rustenburg Nature Reserve as *Loudetia simplex-Aristida aequiglumus* woodlands, shrublands and grasslands.

Within the study area the woodland variation is often dominated by a single woody species namely *Protea caffra* (Coetzee *et al.*1981). This variation dominates southern slopes and high slopes of the Marakele National Park, Entabeni Game Reserve and Groothoek farm as described by Van Staden (in prep.), Westfall (1981) and Newberry (1998) (Fig. 4.5). When altitude increases *Protea caffra* is often substituted by the frost-resistant species *Protea roupelliae* (Van Wyk *et al.* 2000). This community has been described as sparse woodland by Westfall (1981) and occurs at altitudes up to 1900 m in the Kransberg Mountains near Thabazimbi. The habitat is on shallow soils in moderately exposed habitats, whereas the *Protea caffra* variation occurs on moderately exposed lower altitude habitats (Westfall, 1981), with moderately deep soils of the Mispah, Glenrosa, Avalon and Clovelly soil forms. Van Staden (in prep.) described another very sensitive community within this variation as the *Protea caffra-Encephalartos eugene-maraisii* low open woodland, where the extremely rare and endemic cycad species *Encephalartos eugene-maraisii* can be found.

The shrublands common along the crests of the Waterberg escarpment were described by Newberry (1998) and Van Rooyen & Bredenkamp (1999). This variation is dominated by red milkplum *Englerophytum magalismontanum*, although other species like *Elephanthorrhiza burkei*, *Ancylobotrys capensis* and *Myrsine africana* are also frequent (Coetzee *et al.* 1981). Where this variation occurs along rocky areas other woody species like individuals of *Podocarpus latifolius* and *Vangueria infausta* may occur (Van Staden , in prep.). The general habitat is somewhat exposed yet on the warmer western and northern slopes of the escarpment, similarly described by Matthews *et al.* (1991) from the Drakensberg escarpment, on shallow rocky Mispah soils (Van Staden, in prep.).

Grassland communities often occur on the high, exposed mountain tops, and have been described by several authors in different localities (Coetzee *et al.* 1975, Rustenburg Nature Reserve; Bredenkamp, 1975, Suikerbosrand Nature Reserve;

Matthews *et al.* 1994, Drakensberg escarpment). Grasslands in the Waterberg Biosphere Reserve are confined to the Kransberg Mountain Range, where Northeastern Mountain Sourveld (Acocks, 1988) occur. Grass species common within the *Protea caffra-Loudetia simplex* vegetation type, sometimes dominating the grassland variation include the following typical cool grassland species:

Aristida transvaalensis (SG 11, T 4.2)	*Tristachya biseriata* (SG 15, T 4.2)
Panicum natalense (SG 15, T 4.2)	*Andropogon schirensis* (SG 15, T 4.2)
Monocymbium ceresiiforme (SG 17, T 4.2)	*Tristachya rehmannii* (SG 21, T 4.2)
Diheteropogon amplectens (SG 21, T 4.2)	*Loudetia simplex* (SG 27, T 4.2)
Schizachyrium sanguineum (SG 27, T 4.2)	*Eragrostis racemosa* (SG 27, T 4.2)
Trachypogon spicatus (SG 35, T 4.2)	*Themeda triandra* (SG 57, T 4.2)

The grasslands also include typical small shrubs and forbs such as *Rhynchosia totta* (SG 11, T 4.2), *Rhynchosia nitens* (SG 11, T 4.2), *Rhynchosia monophylla* (SG 15, T 4.2),. *Tephrosia longipes* (SG 35, T 4.2), *Xerophyta retinervis* (SG 21, T 4.2) and *Bulbostylis burchellii* (SG 22, T 4.2). The species *Erica drakensbergensis* (SG6, T 4.2) occurs at low frequency (6%), but was included due to it being a strong indicator of cold habitats, also occurring in the snowcovered peaks of the Drakensberg montain range. The general habitat is mostly at high altitude (up to 2100 m in the Kransberg mountain range) summits, and the geology of the Aasvoëlkop and Sandriviersberg formation. Soils are rocky, shallow and of the Mispah form derived from the sandstone of the described geological formations (Westfall, 1981). Figure 4.5 shows the woodland variation of the *Protea caffra-Loudetia simplex* community.

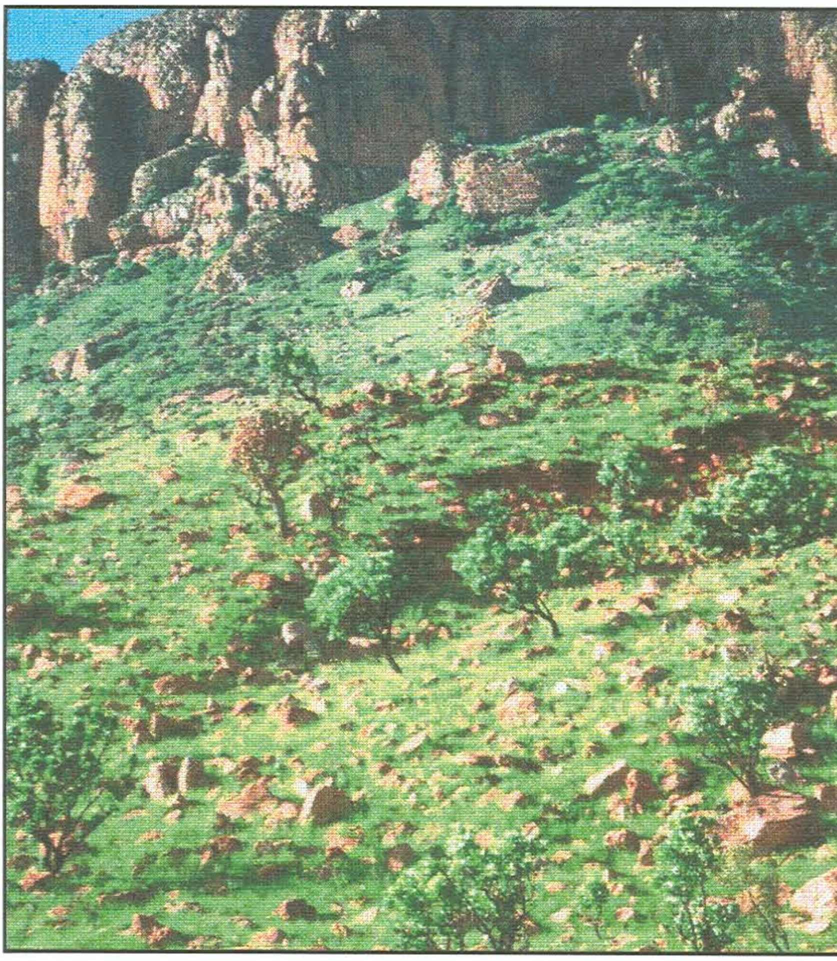

Figure 4.5 Slopes dominated by *Protea caffra* within the Marakele National Park representing the open woodland variation of the *Protea caffra*-*Loudetia simplex* community

5. The *Diplorhynchus condylocarpon-Englerophytum magalismontanum* Rocky Slope Community

This vegetation type is certainly the most widespread and most common community in the Waterberg Biosphere Reserve. Acocks (1988) classified it as Sour Bushveld (A20), while Van Rooyen & Bredenkamp (1996[a]) described it as Waterberg Moist Mountain Bushveld. The plant community is typical of moderately steep to steep warm western and northern rocky slopes within the Waterberg and the following species are characteristic (SG 10, T 4.2):

Hexalobus monopetalus	*Asparagus africanus*
Lantana rugosa	*Tylosemma fassoglense*
Commelina livingstonei	*Pavonia transvaalensis*
Polygala uncinata	*Aristida meridionalis*
Setaria lindenbergiana	*Bulbostylis hispidula*

Several woody species dominate this vegetation type and the combination thereof has been described by Ben-Shahar (1988) within the Lapalala Wilderness area as a specific association between certain species like *Diplorhynchus condylocarpon* (SG 34, T 4.2), *Croton gratissimus* (SG 36, T 4.2), *Combretum molle* (SG 36, T 4.2), *Elephanthorrhiza burkei* (SG 34, T 4.2) and *Pterocarpus rotundifolius* (SG 34, T 4.2). Other typical dominant mountainous species in this vegetation type include *Englerophytum magalismontanum* (SG 36, T 4.2), *Vitex rehmannii* (SG 35, T 4.2), *Pseudolachnostylis maprouneifolia* (SG 34, T 4.2), *Tapiphyllum parvifolium (*SG 14, T 4.2) and *Burkea africana* (SG 26, T 4.2). *Diplorhynchus condylocarpon* is the most dominant woody species within this vegetation type that stretches over a vast area of the Waterberg as seen in the several communities described by different authors (Table 4.3).

Acocks based his Sour Bushveld Veld Type on the low nutritious value of dominant grass species such as *Schizachyrium jeffreysii* (SG 26, T 4.2), *Andropogon schirensis* (SG 15, T 4.2), *Loudetia simplex* (SG 27, T 4.2), *Schizachyrium sanguineum* (SG 27, T 4.2), *Eragrostis racemosa* (SG 27, T 4.2), *Heteropogon contortus* (SG 51, T 4.2) and *Melionis repens sub. repens* (SG 56, T 4.2) (Van Oudtshoorn, 1999).

Table 4.3. Examples of *Diplorhynchus*-dominated communities described within the Waterberg Biosphere Reserve

Author	Place	Plant community name
Du Toit (1998)	Entabeni Game Reserve	*Diplorhynchus condylocarpon-Loudetia simplex*
Fourie (1994)	Kwalata Game Ranch	*Croton gratissimus-Diplorhynchus condylocarpon*
Joubert (1998)	Sambane Game Lodge	*Diplorhynchus condylocarpon-Burkea africana*
Tuinder (1991)	Jobedi Game Lodge	*Diplorhynchus condylocarpon*-savanna
Van Staden (in prep.)	Marakele NP*	*Diplorhynchus condylocarpon-Burkea africana*
Westfall (1981)	Groothoek farm	*Combretum molle-Aristida diffusa*

* NP - National Park

The habitat of this vegetation type is mostly on the northern to northwesterly slopes of the Waterberg. It is described as a deciduous broadleaf savanna of warm, low-lying hilly terrain and slopes (altitude 1250 - 1400 m above sea level) (Coetzee *et al.* 1981). Slopes on which it occurs vary in steepness from 4° to 40°, and it totally dominates the slopes of the Table- lands (see Fig. 3.3, Chapter 3) underlaid by the Mogalakwena and Sandriviersberg geological formations, Group Waterberg. The ground cover is usually very rocky, usually between 40 and 80 % as described by Joubert (1998) and Du Toit (1998) and therefore the herbaceous cover is low (Joubert, 1998). Soils are usually shallow and of the Mispah -, Glenrosa -, Clovelly and Hutton forms (Joubert, 1998; Van Staden, in prep). This specific vegetation type seem to be confined to mountainous terrain on warm, rocky slopes, with high precipitation, since similar vegetation communities were also described by Theron (1973) in the Loskopdam Nature Reserve, Coetzee *et al.* (1976) in the Nylsvley Nature Reserve and Brown *et al.* (1995) within the Borakalalo Nature Reserve, in warm, but wet areas outside the main Waterberg basin (Jansen, 1982). Figure 4.6 shows an example of the typical plant community on the rugged, rocky slopes dominating many parts of the Waterberg Biosphere Reserve.

Winterbach (1998) syntaxonomically classified the Mountain Bushveld of the Central Transvaal under the class *Englerophyto magalismontani-Acacietea caffrae*. However, this class seems to be more restricted to the higher sandstone plateaus and southern slopes of the Waterberg, while the class Terminalio sericeae-Combretetea apiculati seem to have more species belonging to the *Diplorhynchus condylocarpon-*

Englerophytum magalismontanum plant community described above. Winterbach (1998) stated that further studies within the Mountain Bushveld might reveal various different classes.

6. The *Burkea africana-Setaria sphacelata* Undulating Plains, Footslopes, Terraces and Plateaus Community

Although not occurring on quite as rocky and steep areas as the previous plant community, this major plant community is typical of the plateau areas, the footslopes and the undulating plains, all with a rock cover varying between 5 and 30%, which occur throughout the Waterberg Biosphere Reserve. Van der Meulen (1979) described this community as a transitional area between the bottomlands and the uplands, as the *Combretum apiculatum-Eragrostis nindensis* association. The communities occurring within this major plant community in smaller locations, varies greatly as several authors have described it within the Biosphere Reserve (Turner, 1995; Von Holdt, 1995; Furniss, 1998; Van Staden, in prep.). The characteristic species for the vegetation type are as follows (SG 13, T 4.2):

Tristachya leucothrix
Cymbopogon excavatus
Elephanthorhiza elephantina
Senecio barbertonicus
Crassula swaziensis
Euphorbia striata
Leonotis ocymifolia
Eragrostis nindensis
Hypoxis rigidula
Kalanchoe paniculata
Panicum schinzii
Setaria homonyma
Oxalis corniculata

Figure 4.7 show a typical example of the vegetation and surrounding landscape within this plant community.

Figure 4.6 The *Diplorhynchus condylocarpon-Englerophytum magalismontanum* plant community on Waterberg Sandstone within the Kwalata Game Lodge

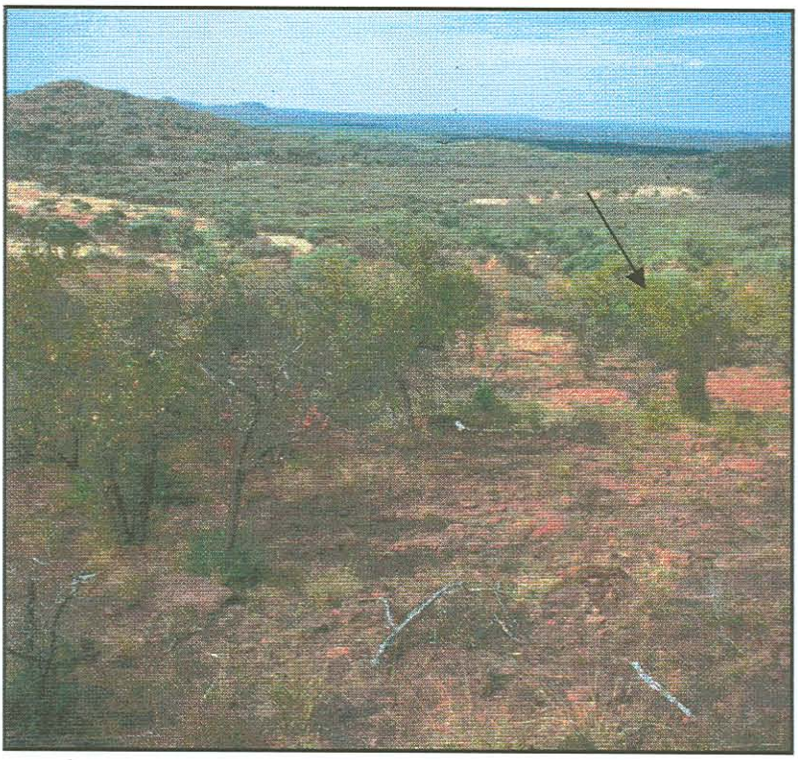

Figure 4.7 A terrace representing the *Burkea africana-Setaria sphacelata* plant community, dominated by *Combretum apiculatum* (arrow)

The structure of the vegetation type is mostly an open woodland (Edwards, 1983) and woody species which occur frequently include the Waterberg endemic *Combretum nelsonii* (SG 14, T 4.2) (Van Wyk & Van Wyk, 1997), and others like *Burkea africana* (SG 26, T 4.2), *Combretum apiculatum* (SG 50, T 4.2), *Ochna pulchra* (SG 26, T 4.2), *Lannea discolor* (SG 34, T 4.2), *Pterocarpus rotundifolius* (SG 34, T 4.2) and *Combretum zeyheri* (SG 16, T 4.2). On the somewhat higher, cooler rocky plateaus and terraces, species like *Burkea africana, Faurea saligna* (SG 36, T 4.2), *Heteropyxis natalensis* (SG 36, T 4.2), *Protea caffra* (SG 15, T 4.2) (also on drainage lines), *Elephanthorrhiza burkei* (SG 34, T 4.2), *Acacia caffra* (SG 36, T 4.2) and *Combretum molle* (SG 36, T 4.2) are more prominent. The grassy layer consist of a combination of typical sour, low nutritious grasses (discussed in previous section), and other more palatable grasses like *Themeda triandra* (SG 57, T 4.2), *Setaria sphacelata* (SG 28, T 4.2) and *Digitaria eriantha* (SG 50, T 4.2) (Van Oudtshoorn, 1999). These decreaser species (Bredenkamp & Van Rooyen, 1991) increase the grazing capacity of this vegetation type and provide an extended grazing period for cattle and game during the winter in the Waterberg, when the sourveld species will be dry and unpalatable.

The plant communities of the undulating plains are well described throughout Southern Africa on different geological formations (Brown & Bredenkamp, 1994, Borakalalo Nature Reserve southern section; Brown *et al.* 1996, Borakalalo Nature Reserve northern section; Gertenbach, 1983, Kruger National Park) (Fig. 3.3, Chapter 3). The communities on the undulating plains fall within the Mixed Bushveld Veld Type and Vegetation Type in the Vaalwater valley as described by Acocks (1988) and Van Rooyen & Bredenkamp (1996[b]) respectively. The undulating areas are dominated by the species *Combretum apiculatum*, with the low lying areas dominated by *Terminalia sericea* (to be discussed in the *Terminalia sericea-Eragrostis pallens* plant community). Von Holdt (1995) described the vegetation of the undulating plains as the *Pterocarpus rotundifolius-Dombeya rotundifolia* woodland on shallow, sandy soils of the Mispah and Glenrosa forms, derived from sandstone of the Vaalwater and Cleremont geological formations within the Slangkuil Game Farm (Fig. 3.2, Chapter 3). Both *C. apiculatum* and *P. rotundifolius* are dominant over large areas of warm, low-lying hilly terrain, similar to the undulating plains in the Vaalwater valley (Coetzee *et al.* 1981).

The communities occurring on the rocky footslopes, terraces and plateaus occur within the Waterberg Moist Mountain Bushveld (Van Rooyen & Bredenkamp, 1996[a]) (Table-lands geomorphological formation, Fig. 3.3, Chapter 3). Furniss (1998) described the *Burkea africana-Aristida scabrivalis* closed woodland on foothills and plateaus of the Emaweni Game Lodge, as a typical example of this community. On the plateaus, the climate may be somewhat cooler than on the footslopes and terraces, Van Staden (in prep.) described a community on the cooler southern parts of plateaus in the Marakele National Park, as the *Faurea saligna-Setaria spaecelata* variation. Where the plateaus and footslopes are somewhat more sandy, species like *Eragrostis pallens* (SG 25, T 4.2), *Perotis patens* (SG 25, T 4.2), *Eragrostis gummiflua* (SG 26, T 4.2) and *Burkea africana* become more prominent. When a layer of clay occurs underneath a thin layer of sand species *like Combretum zeyheri* (SG 34, T 4.2) and *Gymnosporia tenuispina* (SG 15, T 4.2) dominate. The general habitat of footslopes, terraces and plateaus include moderately shallow to deeper sandy soils of the Mispah, Clovelly, Cartref and Constantia soil forms, derived from sandstone of the Mogalakwena and Sandriviersberg formations (Fig. 3.2, Chapter 3).

7. The *Terminalia sericea-Eragrostis pallens* Deep Sandy Lowlands Community

This plant community is typical of the lowland areas within the Waterberg Biosphere Reserve, excluding the northern, more arid parts like Wonderkop Nature Reserve. The typical dominant gras species is *Eragrostis pallens* (SG 25, T 4.2), which grows in association with the woody species *Terminalia sericea* (SG 42, T 4.2) and *Burkea africana* (SG 26, T 4.2) on deep sandy soils and and drainage lines (Van Oudtshoorn, 1999) (Fig. 4.8). Acocks classified this Veld Type under Mixed Bushveld (A18), as *Terminalia* Veld proper. It occurs within the Mixed Bushveld vegetation type (Van Rooyen & Bredenkamp, 1996[b]) on the lowland areas of the moderately undulating plains (Fig. 3.3, Chapter 3), as well as in the valley bottoms of the Table-Lands (Fig. 3.3, Ch. 3) in the Waterberg Moist Mountain Bushveld (Van Rooyen & Bredenkamp, 1996[a]). Several authors described similar specific vegetation communities in phytosociological studies within the Biosphere Reserve and elsewhere dominated by *Terminalia sericea* and *Eragrostis pallens* (Tuinder, 1991, Waterberg Game Centre; Brown & Bredenkamp, 1994, Borakalalo Nature Reserve southern section; Brown *et al.* 1995, Borakalalo Nature Reserve western section; Von Holdt, 1995, Slangkuil

Game Farm; Du Toit, 1998, Entabeni Nature Reserve). Van der Meulen (1979) describes the structure as a multi-layered, semi-closed to closed woodland (Edwards, 1983). The typical characteristic species include the following several dominant forbs, shrubs and grass species associated with sandy areas:

Melinis repens s. *grandiflora*	*Kohautia virgata*
Cyperus margaritaceus	*Aristida mollis*
Strychnos cocculoides	*Securidaca longipedunculata*
Agathisanthemum bojeri	*Nidorella hottentotica*
Pollichia campestris	*Diheteropogon filifolius*

Other typical sandveld dominants include *Bulbostylis burchellii* (SG 22, T 4.2), *Diheteropogon amplectens* (SG 21, T 4.2), *Chamaechrista mimisoides* (SG 24, T 4.2), *Perotis patens* (SG 25, T 4.2), *Ochna pulchra* (SG 26, T 4.2), *Eragrostis gummiflua* (drainage lines; SG 26, T 4.2), *Combretum zeyheri* (SG 34, T 4.2), *Commelina africana* (SG 43, T 4.2), *Waltheria indica* (SG 50, T 4.2) and *Melinis repens* s. *repens* (SG 51, T 4.2). Closer to footslopes and low lying areas close to dolerite dykes and streams, a sandy layer usually overlays a layer of clay. Sweetveld associated species (Acocks, 1988) like *Dichrostachys cinerea* (SG 55, T 4.2), *Digitaria eriantha* (SG 50, T 4.2), *Panicum maximum* (SG 50, T 4.2) and *Schmidtia papophoroides* (SG 54, T 4.2) become more conspicuous then. Von Holdt (1995) and Brown *et al.* (1996) described these variations as the *Terminalia sericea-Digitaria eriantha* woodland and *Terminalia sericea-Ozoroa paniculosa* tall closed woodland. Winterbach (1998) further stated that the syntaxonomic class *Terminalio sericae-Combretetea apiculati*, which is also represented by this plant community, forms a mosaic with the *Panico maximi-Acacietea tortilis* in the slightly undulating landscape of the Mixed Bushveld, explaining why certain sweet bushveld elements occur in this plant community.

Figure 4.8. A typical low-lying area dominated by *Terminalia sericea* (arrow) within the Emaweni Game Lodge, representative of the *Terminalia sericea-Eragrostis pallens* plant community

The habitat of this plant community is typically on deep sandy soils of the Cartref-, Clovelly and Constantia soil forms. The sandy soils of the Mixed Bushveld in the Vaalwater valley are derived from sandstone of the Vaalwater and Cleremont formations (Fig. 3.2, Ch. 3), while the sands of the valley bottoms in the Waterberg Moist mountain bushveld originates from weathering of the Sandriviersberg and Mogalakwena Sandstone formations (Fig. 3.2, Ch. 3). The sandy soils within this plant community are heavily leached due to the high rainfall (600 - 900 mm) which occurs in the area (Van Rooyen & Bredenkamp, 1996[a]). These low-lying sandy areas were previously used by farmers to cultivate crops. However, the costs involved for fertilizers on these poor soils were probably too high and these fields were later abandoned. The plant community associated with these old cultivated fields is discussed in the following section.

8. The *Cynodon dactylon-Dichrostachys cinerea* Old Fields and Disturbed Areas Community

This plant community is typical of old abandoned fields as well as disturbed sites within the Waterberg Biosphere Reserve. It occurs throughout Biosphere Reserve and was described by several authors in many phytosociological studies within the study area (Turner, 1995, Waterberg Game Centre; Von Holdt, 1995, Slangkuil Game Farm; Du Toit, 1998, Entabeni Nature Reserve Mmadikiri section; Furniss, 1998, Emaweni Game Lodge; Joubert, 1998, Sambane Game Lodge; Newberry, 1998, Entabeni Nature Reserve). It occurs especially in the sandy areas around Vaalwater and Melkrivier. Typical species of disturbed areas (Van Wyk & Malan, 1988; Van Oudtshoorn, 1999) characterize this community namely (SG 23, T 4.2):

Cynodon dactylon	*Hyperrhenia hirta*
Hyperthelia dissoluta	*Solanum incanum*
Terminalia brachystemma	*Eragrostis chloromelas*
Bidens pilosa	

Other dominant disturbed-field associated species include *Oldenlandia herbacea* (SG 26, T 4.2), *Fadogia homblei* (SG 27, T 4.2), *Eragrostis curvula* (SG 33, T 4.2), *Solanum panduriforme* (SG 39, T 4.2), *Pogonarthria squarrosa* (SG 49, T 4.2), *Digitaria eriantha* (SG 50, T 4.2) and *Dichrostachys cinerea* (SG 55, T 4.2).

When cultivated fields are left fallow, it results in a landscape mosaic of patches of secondary vegetation varying in age and dominated by various grass species (Moll, 1965). Different stages of succession occur in the old fields. The most common old fields in the Waterberg Biosphere Reserve are the young old fields of 1-5 years old (Smits *et al.* 1999, Transkei) dominated by the pioneer grass species of disturbed areas, *Cynodon dactylon* (Van Oudtshoorn, 1999). A syntaxonomic study in the old fields of the Transkei revealed this type of old field variation as the *Tageto minutae-Cynodonetum dactyli*. It has been studied extensively and described by Turner (1995), Joubert (1998) and Newberry (1998) in the study area. Although the species *Cynodon dactylon,* is not a very productive grass, it is palatable and a moderate to good grazing grass (Van Oudtshoorn, 1999). It is often heavily grazed by animals in game reserves and game farms in the Biosphere Reserve. The heavy grazing by game however, can cause trampling and erosion of these areas and the management of these areas are extremely important (Brown & Bredenkamp, 1994). Secondary grassland communities may develop from this old field variation as shown by Smits *et al.* (1999) in the old fields of the Transkei, dominated by the secondary grassland species directly related to man-made disturbances, *Hyparrhenia hirta* (Rivers-Moore, 1997). These fields are still in a early successional state, although somewhat older (older than 5 years) with several grass species like *Hyperthelia dissoluta, Aristida junciformis* (SG 29, T 4.2), *Aristida congesta* s. *congesta* (SG 56, T 4.2) and *Eragrostis rigidior* (SG 54, T 4.2). Furniss (1998) described this variation as the *Hyparrhenia hirta-Felicia muricata* short closed grassland on the Emaweni Game Lodge in the Waterberg Biosphere Reserve. This old field successional stage is often managed by fire for tourism purposes, to lure game to these areas. If left undisturbed and unmanaged, the unpalatable *Hyperrhenia hirta* (Van Oudtshoorn, 1999) will invade these old fields and game will flock to other areas where it is more difficult for tourists to view them.

The outer successional stage of old fields only starts after several years of abandonment when woody species start to invade. These secondary old fields are usually dominated by species such as *Dichrostachys cinerea, Terminalia sericea* (SG

42, T 4.2), *Acacia karoo* (SG 54, T 4.2) and *Ziziphus mucronata* (SG 56, T 4.2). Where overgrazing occurs the encroacher *Dichrostachys cinerea* becomes dominant (Bothma, 1995). These communities occur especially on areas on game farms previously overgrazed by cattle. Bell (1997) described a disturbed overgrazed community as *Dichrostachys cinerea-Hyperthelia dissoluta* tall closed grassland at Mabula Game Reserve in the foothills of the Waterberg, while Von Holdt (1995) classified a similar community as the *Dichrostachys cinerea-Eragrostis rigidior* encroached shrubland in the Slangkuil Game Farm. In sandy old fields (Cartref, Clovelly and Constantia soil forms) the dominant tree species to invade is usually *Terminalia sericea* (Brown *et al.* 1995), while the invasive species on clayey soils of the Hutton and Fernwood forms is *Acacia karoo* (Joubert, 1998).

As stated earlier, the habitat type of the old fields coincide with the habitat of the lowlands which is more suitable for agricultural practices. Other areas where old fields occur is on the sandy terraces and plateaus of the Table-lands geomorphological type (Fig. 3.3, Ch. 3). The value of these old fields to game farmers will be emphasized even more in the following chapter. Figure 4.9 shows a typical old field in an early successional stage within the Waterberg Biosphere Reserve

9. The *Dombeya rotundifolia-Panicum maximum* Sweet Rocky Community

This plant community is associated with the diabase and dolerite dykes within sheltered dykes and rocky outcrops within the Biosphere Reserve, as well as to the mountainous vegetation of the Arid Sweet Bushveld Veld Type (Acocks, 1988) of Wonderkop Nature Reserve in the northern part of the Waterberg Biosphere Reserve. The main geological formations of the Waterberg basin consist of sandstone (Jansen, 1982). However, the area has also been intruded by diabase (Pre - Karoo) and dolerite (Post - Karoo) dykes, as both irregular bodies and sheets (O'Connor, 1992) (Fig. 4.10). Vegetation associated with these intrusions usually has sweet bushveld-associated elements due to the rich soils derived from the geological formations (Smit *et al.* 1995).

Figure 4.9. An old field within the Entabeni Nature Reserve dominated by *Cynodon dactylon*

Figure 4.10. The *Dombeya rotundifolia-Panicum maximum* plant community represented within the Doorndraaidam Nature Reserve along a dolerite dyke

The most prominent characteristic species, mostly woodies, of this plant community is the following (SG 30, T 4.2):

Bridelia mollis	*Schotia brachypetala*
Kirkia acuminata	*Spirostachys africana*
Ximenia americana	*Fluegga virosa*
Enneapogon scoparius	*Euphorbia cooperi*
Obetia tenax	*Clerodendrum glabrum*
Aloe marlothii	

Other dominant woody species also included in the *Diplorhynchus*-community of rocky slopes (SG 34, T 4.2; SG 36, T 4.2), that are typical Waterberg associated species, also occur in this sweet vegetation type of mountainous areas. Species similarly described characteristic of bouldery and broken areas of diabase geology are *Kirkia acuminata, Sclerocarya birrea* (SG 47, T 4.2) and *Acacia nigrescens* (SG 47, T 4.2) (O'Connor, 1992). The only characteristic grass species, *Enneapogon scoparius,* associated with rocky, shallow soils indicate the rocky, mountainous terrain, although sweet grass species like *Panicum maximum* (SG 50, T 4.2), *Digitaria eriantha* (SG 50, T 4.2) and *Schmidtia pappophoroides* (SG 54, T 4.2) indicate the richer soils (Van Oudtshoorn, 1999). The habitat is very rocky and the large rocks protect young trees against fire and frost (Smit *et al.* 1995). Furniss (1998) and Newberry (1998) have described the vegetation of rocky diabase outcrops in the Biosphere Reserve. The *Dombeya rotundifolia-Setaria homonyma* short closed woodland community at Entabeni Game Reserve (Newberry, 1998) and *Acacia nigrescens-Pavonia burchellii* low forest community on the slopes of Tafelkop at Entabeni Game Reserve represent good examples of this plant community in mountainous areas. These vegetation communities are directly related to geology and soil types (Van Rooyen & Theron, 1996). The soil type on which these communities occur are mostly the Hutton soil form.

The vegetation of Wonderkop Nature Reserve (Field Survey, 2002) in the Arid Sweet Bushveld (A14; Acocks, 1988), are not related to the diabase outcrops previously described. These vegetation communities are more exposed to drier conditions and therefore species like *Euphorbia cooperi, Aloe marlothii, Euphorbia ingens* (SG 36, T

4.2), *Boskia albitrunca* (SG 47, T 4.2) and *Commiphora mollis* (SG 47, T 4.2) are more dominant, with *Combretum apiculatum* dominating the plateaus and foothills on conglomerate of the Mogalakwena formation. The much lesser rainfall within this area (452 mm for Marken, Weather Bureau, 2000) may possibly cause the absence of typical Waterberg Sandstone species like *Diplorhynchus condylocarpon and Englerophytum magalismontanum;* while species like *Pseudolachnostylis maprouneifolia* and *Elephanthorrhiza burkei* indicate the strict association of certain species with Waterberg Sandstone (Mogalakwena formation), These species are thus able to survive under wet and dry conditions in the BR. Van Rooyen *et al.* (1981) and Du Plessis (2001) described communities under similar rainfall patterns on Waterberg Sandstone in the Punda Milia-Pafuri-Wambiya Sandveld area of the Kruger National Park.

The low-lying, sheltered vegetation variation along rocky dykes are similar to the *Spirostachys africana-Sporobolus ioclados* Woodland on granite described by Van der Meulen (1979) in the Central Bushveld. This variation occurs on more clayey soils (Oakleaf, Westleigh and Milkwood forms), sometimes with a rock layer underneath and varied rock cover above ground. Species like *Spirostachys africana, Schotia brachypetala, Euclea undulata, Olea europaea* SG 36, T 4.2), *Berchemia zeyheri* (SG 36, T 4.2), *Mimusops zeyheri* (SG 36, T 4.2), *Combretum hereroense* (SG 38, T 4.2), *Ziziphus mucronanta* (SG 56, T 4.2) and *Acacia karroo* (SG 54, T 4.2) are more associated with this heavier, clayey soils (Van Wyk & Van Wyk, 1997). The structure of this community is usually a tall closed woodland (Edwards, 1983), although Turner (1995) described the *Spirostachys africana* short forest community on the Mokolo River Nature Reserve. Van Rooyen & Bredenkamp (1999) described a dolerite dyke community in the Suikerboshplaat Game Farm as the *Dombeya rotundifolia-Acacia karroo* stream banks community, while von Holdt (1995) described a similar community as the *Euclea undulata - Panicum maximum* riverine thicket in the Slangkuil Game Farm.

10. The *Acacia tortilis-Panicum maximum-Ziziphus mucronata* Termitaria and Encroached Areas Community

This plant community occurs under specific conditions. It consist of two variations namely vegetation associated with termitaria throughout the Biosphere Reserve and vegetation associated with encroached areas, especially near Thabazimbi in the southwestern corner of the Biosphere Reserve. The encroached areas and termitaria are often closed, thicket-like woodland with a sparse ground cover. However, shade-loving grass species such as *Panicum maximum* often occurs (Van Oudtshoorn, 1999). Species composition of these vegetation variations tends to be variable, since specific species will thrive under different conditions. The characteristic species for this vegetation type include the following species (SG 37, T 4.2):

Acacia erioloba	*A. erubescens*
A. burkei	*Ehretia rigida*
Sporobolus iocladus	*S. fimbriatus*
Brachiaria eruciformis	*Eragrostis trichophora*
Tephrosia capensis	*Maytenus polyacantha*
Achyropsis avicularis	*Hibiscus pusillus*
Cyphostemma cirrhosum	*Kalanchoe lanceolata*
Justicia protracta	*Jasmium breviflorum*
Blepharis integrifolia	

Vegetation associated with termitaria has been studied and described by Coetzee *et al.* (1976) in the Nylsvley Nature Reserve and Van Staden (in prep.) in the Marakele National Park within the Biosphere Reserve. This variation often form impenetrable, thorny bushclumps on low mounds built by termites (Van der Meulen, 1979). The size of termitaria determines the structure of vegetation. Tall trees like *Pappea capensis* (SG 45, T 4.2), *Combretum imberbe* (SG 46, T 4.2) and *Ziziphus mucronata* are common, with several *Grewia* species also being part of the lower structure of the termitaria vegetation (Fig. 4.11). The *Acacia* species and other sweetveld associated vegetation occur on termitaria due to the depth and aeration, better drainage, as well as the finer texture and higher nutrient status of the soil (Lee & Wood, 1971). Coetzee *et al.* (1976) described termitaria within the Nylsvley Nature Reserve as communities of flat bottomlands and of termitaria on alluvium. However, termitaria also occur on plateaus, terraces and lowlands on sandy to loamy soils without rocks, as termites need a certain depth of soil for their activities (Van der Meulen, 1979). Van Staden (in prep.) described the *Rhus leptodictya-Mimusops zeyheri* termitarium thickets in the Marakele National Park as an example. A typical termitaria community is shown in figure 4.11.

Vegetation associated with encroached areas usually occurs in previously disturbed or overgrazed sites (Van der Meulen, 1979). Werger (1977) showed that when severe and prolonged overgrazing in the semi-arid savanna ecosystem occurs, the grass component is severely restricted in growth, or in moisture usage. More moisture remains thus available in the soil to be used by the woody plants, and the result is bush encroachment, a structural change towards a more strongly woody vegetation (Werger, 1977). Typical examples occur in Marakele National Park near Thabazimbi, especially at sites where old cattle farms, where heavy grazing occurred and were later changed to be part of the park (Coetzee *et al.* 1981). Typical encroachers like *Dichrostachys cinerea* (SG 55, T 4.2), *Acacia erubescens* and *Acacia mellifera* (SG 46, T 4.2) occur in this vegetation variation, on somewhat deeper sandy to loamy soils compared to termitaria (Werger & Coetzee, 1978). Sometimes almost pure stands of these species might occur when conditions favour a certain species. Van der Meulen (1979) described it as one of the most seriously disturbed types of vegetation in the Central Bushveld, with overgrazing, trampling and erosion being common problems. Ecological management need therefore be implemented in these areas to adress the problem. The geology of the encroached areas at Thabazimbi is granite, granophyre, sandstone, shale and mudstone (Geological Survey, 1970). Other encroached areas also occur on diabase dykes in the Wonderkop Nature Reserve and other plain areas of the Biosphere reserve.

Figure 4.11. A typical termitaria with its associated vegetation within the Nylsvley Nature Reserve

11. The *Acacia nigrescens-Grewia flava* Plains Community

This plant community includes the vegetation of the northern plains (near Marken), classified by Acocks (1988) as Arid Sweet Bushveld, *Grewia flava* variation. However, Coetzee (1971) classified a similar vegetation type as *Acacia-Grewia* Veld due to it being on the transition zone of the Arid Sweet and Mixed Bushveld. Schmidt (1992) and Pauw (1988) described similar communities within the Rhino Ranch and Atherstone Nature Reserve outside the Biosphere Reserve respectively, and these communities are similar to the plains around Marken. The correlation between soil and vegetation is strong in this low rainfall areas (O'Connor, 1995). The most prominent characteristic species are the following, mostly dominated by forbs and grass species (SG 45, T 4.2):

Melhania acuminata	*Enneapogon cenchroides*
Achyrantes aspera	*Bothrichloa radicans*
Urochloa panicoides	*Tephrosia purparascens*
Melhania rehmannii	*Ehretia amoena*
Boscia foetida	*Commiphora africana*
Aristida rhinochloa	*Cenchrus ciliaris*

The landscape geomorphology within which the vegetation occurs consists of plains with slightly undulating areas where shallower, rocky soils occur. On the rockier areas, the soils are of the Mispah-, Hutton or Cartref soil forms. Schmidt (1992) and Pauw (1988) have described the vegetation variation as the *Combretum apiculatum-Acacia nigrescens* short closed woodland and the *Grewia bicolor-Combretum apiculatum* short open woodland communities, respectively. Species dominant within these communities are typically associated with rocky areas like *Enneapogon cenchroides*, *Combretum apiculatum* (SG 50, T 4.2), *Schmidtia papophoroides* (SG 54, T 4.2) and *Acacia nigrescens* (SG 47, T 4.2). The other variant of this vegetation type is typical of the low-lying plain areas with more typical thornveld (Fig. 4.12). Schmidt (1992) classified this variation as the *Acacia nigrescens - Grewia flava* tall open woodland on Hutton soils originated from anorthosite and gabroid rock. Typical species include *Acacia tortilis* (SG 53, T 4.2), *Grewia* species, *Acacia karroo* (SG 54, T 4.2), *Dichrostachys cinerea* (SG 55, T 4.2), *Panicum maximum* (SG 50, T 4.2) and

Chloris virgata (SG 53, T 4.2). The geology underlying this vegetation is variable, and it seems as though rainfall plays an overcoupling role in determining vegetation communities, as stated earlier. Again, the high and low lying areas form a mosaic as described by Winterbach (1998). The typical plains dominated by several woody species is shown in figure 4.12.

12. The *Setaria incrassata-Aristida bipartita* Vertic Clay Community

This community is restricted to the area adjacent to the floodplain (*Phragmites australis-Persicaria serrulata*) in the Nylsvley Nature Reserve. It forms part of the Clay Thorn Bushveld as described by Van Rooyen & Bredenkamp (1996[c]). Although specific herbaceous species from species group 52, like *Berkheya radula, Jamesbrittenia aurantiaca, Scilla dracomontana, Senecio apiifolius, Salvia repens* and *Falckia oblonga* characterize this vegetation type, the typical woody and grass species growing in clay soils are more prominent as discussed below. Figure 4.13 show the typical plant community in the Nylsvley Nature Reserve.

Grass species like *Aristida bipartita* (SG 59, T 4.2), *Setaria incrassata* (SG 58, T 4.2) and *Themeda triandrae* (SG 57, T 4.2) are typical grasses growing in vertic clays (Van Oudtshoorn, 1999). Coetzee *et al.* (1976) described this plant community mainly as grassland with an open stand of thorn savanna. The typical dominant scattered woody species growing in the clayey soils include *Acacia nilotica, A. tortilis* (SG 53, T 4.2), *A. karroo, Rhus pyroides* (SG 54, T 4.2) and *Ziziphus mucronata* (SG 56; T 4.2). The typical clayey soil is derived from basalt and of the Arcadia soil form. Habitat features as described by Coetzee *et al.* (1976) include a fluctuating water table, prolonged periods of inundation during heavy rainfall, swelling and contraction of the soil during wet and dry periods with considerable cracking when dry, a loose soil surface, a high calcium content in the soil and gilgai micro-relief. Bredenkamp & Deutschländer (1994) classified a similar vegetation association as the *Themedo triandrae-Setarietum incrassatae* in vertic clay soils on gabbro in the Manyeleti Game Reserve of the Eastern Transvaal Lowveld, while Van der Meulen (1979) classified it as woodland of vertic black clays (*Acacia tortilis-Aristida bipartita* woodland association) in the Central Bushveld.

Figure 4.12 Plains in the Wonderkop Nature Reserve representing the *Acacia nigrescens - Grewia flava* major plant community

Figure 4.13 The *Setaria incrassata-Aristida bipartita* community on the vertic clay soils in the Nylsvley Nature Reserve

4.4 Conclusion

The classification of the vegetation within the Waterberg Biosphere Reserve as represented by several datasets combined in a database revealed 12 different plant communities as follows:

- The *Fuirena pubescens-Andropogon huilensis* sponge community
- The *Phragmites australis-Persicaria serrulata* vlei community
- The *Protea caffra-Loudetia simplex* cool slopes and escarpment crest community
- The *Podocarpus latifolius-Diospyros whyteana* kloof community
- The *Diplorhynchus condylocarpon-Englerophyton magalismontanum* rocky slope community
- The *Burkea africana-Setaria sphacelata* undulating plains, footslopes, terraces and plateaus community
- The *Terminalia sericea-Eragrostis pallens* deep sandy lowlands community
- The *Cynodon dactylon-Dichrostachys cinerea* old fields and disturbed areas community
- The *Dombeya rotundifolia-Panicum maximum* sweet rocky community
- The *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria and encroached areas community
- The *Acacia nigrescens-Grewia flava* plains community
- The *Setaria incrassata-Aristida bipartita* vertic clay community

The plant communities are strongly correlated along environmental parameters. The main environmental factor to which the communities are correlated is the underlying geology. The last three vegetation types represent the sweet vegetation underlaid by Pre- and Post Waterberg rocks along the edges of the main Waterberg basin, while the other vegetation types are all underlain by Waterberg Sandstone, within the Waterberg Biosphere Reserve. Other factors, which played a role in distinguishing plant communities were rainfall, rockiness and soil type.

Each of the different plant communities would represent a specific habitat for mammals and birds, with specific trees growing in it, which are great attractions for tourists visiting the area. The plant communities further fits into the landscape geomorphology to form ecosystems (ecozones). These ecozones will be identified, described and mapped within the Waterberg Biosphere Reserve in the following chapter.

Table 4.2 Synoptic Table of the plant communities of the Waterberg Biosphere Reserve

Vegetation type	1	2	3	4	5	6	7	8	9	10	11	12
Number of releves	11	3	43	90	387	156	182	432	44	76	48	5
Species Group 1												
Fuirena pubescens	82											
Helichrysum aureonitens	73					8		1				
Monopsis decipiens	73					1		4		1		
Hypericum lalandii	64			2		6		2				
Andropogon huillensis	64		5									
Sebaea leiostyla	64											
Xyris capensis	55		5									
Cyperus kirkii	55											
Ascolepis capensis	55		2									
Arundinella nepalensis	46											
Drosera madagascariensis	46											
Chironia purpurascens	36			1		8						
Kyllinga alba	36							3				
Pycnostachys reticulata	36											
Aster species	36											
Lobelia erinus	36											
Eragrostis inamoena	36											
Leersia hexandra	27		5									
Disa woodii	27											
Eragrostis capensis	27		2	6				4				
Senecio affinis	27											
Senecio polyodon	27											
Panicum dregeanum	27		2									
Pennisetum sphacelatum	27											
Helichrysum epapposum	27											
Eriochrysis pallida	27											
Dierama medium	27											
Nemesia fruticans	27		2	6								
Sopubia simplex	18											
Asclepias brevipes	18											
Oldenlandia tenella	9											
Species Group 2												
Phragmites australis		100	5					2				
Persicaria serrulata		100										
Nymphoides species		33										
Juncus dregeanus		33										
Ceratophyllum species		33										
Centella species		33										
Species Group 3												
Verbena bonariensis	46	33	2					4				
Cyperus species	64	33			4			4		3		

Species Group 4									
Podocarpus latifolius		54	9		4				
Cyperus albostriatus		49	2		1				
Myrsine africana		44	1		8				
Celtis africana		40						7	1
Cheilanthes viridis	9	40	3	9	1	2		7	
Secamone alpini		37	1	2	1				
Asparagus virgatus		35				2			1
Osyris lanceolata		26		2	4			7	
Syzygium cordatum		26		1	5				
Ficus sur		26			1				
Acokanthera oppositifolia		23							
Buxus macowanii		23							3
Tricalysia lanceolata		23		1					
Curtisia dentata		21							
Cryptolepis transvaalensis		21		1				5	
Calpurnia aurea		21						7	
Clutia pulchella		19	3	4	1			2	
Rothmannia capensis		19	7	3	2				
Kirkia wilmsii		19		1				9	
Plectranthus fruticosus		19							
Ischaemum fasciculatum	9	19			2				
Canthium gilfillanii		19		8		2		5	
Widdringtonia nodiflora		16	6						
Solanum giganteum		16		1	5			5	8
Asplenium splendens		16							
Pittosporum viridiflorum		16		1					
Syzygium guineense	9	14		2					
Vepris lanceolata		14							
Setaria megaphylla		14		1				2	
Dovyalis zeyheri		14			3			5	1
Blechnum attenuatum		12							
Ochna holstii		12							
Grewia occidentalis		12		2				9	1
Pterocelastrus echinatus		12							
Abrus laevigatus		12		1				2	
Cussonia spicata		12	4	4					1
Species Group 5									
Miscanthus junceus	36	21		1			2		
Ilex mitis	9	21							
Cliffortia linearifolia	9	16							
Species Group 6									
Indigofera hedyantha			46						
Acalypha angustata			44		1				
Stachys natalensis		2	34	9	4				
Anthospermum hispidulum			32			1	2	7	
Vernonia galpinii			30	2	4	2			
Thesium utile			27	2		2	7		1
Polygala hottentotta			23	1	4	5	1		
Cheilanthes hirta		9	23	5					
Protea roupelliae			22						
Helichrysum nudifolium			21		3	3			
Aeschynomene rehmannii			21	2					

Berkheya carlinopsis				20	2					
Helichrysum mimetes				20						
Pentanisia angustifolia				19			1			
Gerbera viridifolia				17						
Indigofera mollicoma				16	7		2	1		
Gnidia capitata				16	1	5	4	2	2	
Eriospermum species				16	3	5				
Hypoxis iridifolia				16		6		2		5
Athrixia elata			2	16		1				
Gerbera piloselloides			7	14	1	1				
Scilla nervosa				13		1				
Cymbopogon validus			5	13	2	5				
Tephrosia elongata				13			1			
Helichrysum uninervium				13						
Phymaspermum bolusii				13						
Talinum caffrum				12	4	2			5	
Vernonia natalensis				12	1	4		3		1
Selago capitellata				12						
Pearsonia cajanifolia				12				2		
Helichrysum dasycephalum				12						
Berkheya zeyheri				12						
Passerina montana			7	11						
Cyperus rupestris				11	2	1		6	2	
Rhus magalismontana				10	4		1			
Digitaria brazzae	9			10	2		4			
Kohautia cynanchica			2	10	1	1				
Coleochloa setifera	9		7	10	3					
Mohria caffrorum			7	10	1					
Aristea woodii				10						
Senecio coronatus				10						
Dimorphotheca jucunda				9						
Erica drakensbergensis				6						
Species Group 7										
Pteridium aquilinum			26	14						
Species Group 8										
Helichrysum species		67	2	37		4				
Species Group 9										
Cyperus leptocladus	55		9	24	7	3				
Species Group 10										
Asparagus africanus					19		2	4	5	7
Hexalobus monopetalus					18	3			2	
Setaria lindenbergiana			9	4	17	2			9	
Lantana rugosa				2	16	5	8	8	9	1
Aristida meridionalis				2	14	2		6	9	4
Tylosema fassoglense					12				5	
Pavonia transvaalensis					12		6	1		
Bulbostylis hispidula				2	12		5	2	2	
Trichocladus grandiflora				2	11	10	2	6	2	
Commelina livingstonii					10	4		1		

Species Group 11											
Aristida transvaalensis	9			23	18		6	5			
Rhynchosia nitens				16	13	2	3				
Rhynchosia totta				26	11	4	3	1			
Sphenostylis angustifolia				26	11	3					
Species Group 12											
Polygala uncinata	27			9	14	2					
Species Group 13											
Tristachya leucothrix				7	6	36		2			
Cymbopogon excavatus				4	3	28	2	5	7	1	
Eragrostis nindensis				1	3	22	3	5			
Hypoxis rigidula				9	3	22		2	2		
Setaria homonyma						15			5		
Hypericum aethiopicum				6		12					
Cymbopogon species				3		12					
Bulbostylis boeckeleri						12					
Kalanchoe paniculata					8	12	1	5	7	5	
Stoebe vulgaris					1	11		7			
Eragrostis superba				1	2	11	7	5	5		4
Crassula swaziensis				6	3	10					
Euphorbia striata						10					
Species Group 14											
Indigofera melanadenia				1	24	35		10			
Rhus gracillima				8	18	25		4			
Tapiphyllum parvifolium				4	37	13			9		
Aristida scabrivalvis				1	10	12		4			
Combretum nelsonii					12	12	1	4	7		
Species Group 15											
Protea caffra				44	3	37		2	2		
Senecio venosus			5	18	7	33	5	3			
Panicum natalense			2	64	3	31	8	6		1	
Ectadiopsis oblongifolius			2	10	23	24	6	2			
Bewsia biflora				12	3	22	7	3			
Vernonia staehelinoides				18	5	19	2	3	2		
Ancylobotrys capensis			2	10	11	18	3				
Melinis nerviglumis				24	17	18	8	5			
Scabiosa columbaria				16		17				1	
Helichrysum kraussii				42	4	16		8			
Maytenus tenuispina			2	13	40	13	3	8	9	4	
Rhynchosia monophylla				33	2	12	6				
Senecio conrathii				20		12					
Helichrysum cephaloides				31		12					
Oxalis depressa			7	11	3	11		4	5	1	
Helichrysum setosum				12	1	11					
Andropogon schirensis				72	34	10	2	4	9		
Tristachya biseriata				16	2	7					
Species Group 16											
Apodytes dimidiata			12	4	8	19			2		
Rhus dentata			16	32	11	18			5		
Olea capensis			14			15			7		

Species Group 17											
Senecio erubescens	36			1		13					
Monocymbium ceresiiforme	46		2	48	3	11	4	1			
Species Group 18											
Melinis repens s grandiflora					1		81		2		
Cyperus margaritaceus					2		72	4			
Kohautia virgata	9		5		2		65		2		4
Justicia species				1	3		59				
Aristida mollis							52				
Lophiocarpus tenuissimus							42				
Diheteropogon filifolius							37				
Hermannia tomentosa				7	7		37	3			
Tephrosia burchellii							35				
Strychnos cocculoides					2	3	34	2	5		
Striga asiatica					2		34	2			
Tephrosia forbesii							32				
Ledebouria graminifolia							31				
Crabbea hirsuta					2		31			1	
Dichapetalum cymosum					2	2	30	2			
Securidaca longepedunculata					1		29			1	
Pollichia campestris					2	3	26	7			
Kohautia caespitosa				2			25				
Elephantorrhiza obliqua						3	25				
Ipomoea obscura				1	5	5	23	3	2	3	
Nidorella hottentotica							22	1			
Rhynchosia longiflora							21				
Tragia rupestris				1	1		20		2	3	
Pentarrhinum insipidum							20				
Phyllanthus maderaspatensis							20				
Vernonia oligocephala				7		6	19	2	2		
Justicia anagalloides							19			3	
Agathisanthemum bojeri					9	5	19	8		3	
Loudetia flavida					2		18		7		
Spermacoce senensis				2			18	1			2
Cleome rubella							15	2			
Hypoxis hemerocallidea					4		15				
Hibiscus engleri					7		13	1		9	
Gomphocarpus fruticosus					1		13	5			
Crabbea angustifolia				1	1		13	1			
Cymbopogon plurinodis				4	4	1	12	7	5	1	
Chamaecrista absus							11				
Chamaesyce inaequilatera							10			5	
Species Group 19											
Triumfetta sonderi				1	6	16	18	5			
Lannea edulis				3	5	16	16	4			
Ximenia caffra					8	11	14	1	9	7	
Digitaria monodactyla			2	6	5	14	13	2		1	
Species Group 20											
Cleome maculata				4	16	7	59	5			
Limeum viscosum				2	16		54	4			
Strychnos pungens				3	46	10	48	9	9		

Aristida aequiglumis				3	16	5	34	2	2		
Aristida diffusa				3	18		17	3		3	
Indigofera filipes				6	10	2	16	3	2		
Vitex pooara					14	6	13	1	9		
Mundulea sericea				2	26	7	13	7	7	4	
Species Group 21											
Diheteropogon amplectens			5	46	38	60	62	9	2		
Elionurus muticus				16	12	17	48	7			
Brachiaria serrata				21	16	10	43	6	9	1	
Chaetacanthus costatus	9			41	2	3	34		2		
Urelytrum agropyroides				33	5	10	28	2			
Parinari capensis				17	15	29	26	6	2		
Pygmaeothamnus zeyheri				13	5	14	18	5			
Xerophyta retinervis				31	25	9	18	4	5		
Dicoma anomala				48	10	18	14	2			
Tristachya rehmannii				21	2	3	13	1			
Indigofera comosa				14	9	14	12	2			
Species Group 22											
Bulbostylis burchellii	9	67	2	77	13	12	69	7			2
Species Group 23											
Cynodon dactylon				3	2		3	27	9	5	2
Hyperthelia dissoluta	9				2	3	3	18	2		
Hyparrhenia hirta	9		2	3		7	3	16	2		
Terminalia brachystemma					4	1	2	16		5	
Bidens pilosa			2		7	5	2	14	7	3	
Solanum incanum			2	8	3	6	3	11	9	5	2
Eragrostis chloromelas			7	2	6	3		11	5		2
Species Group 24											
Indigofera daleoides					7	6	36	19	2		2
Trichoneura grandiglumus				1	8	2	19	18			
Chamaecrista mimosoides				9	5	5	52	10	5		
Species Group 25											
Aristida stipitata					8	19	35	32		1	
Perotis patens				3	5	10	78	28	2	1	
Eragrostis pallens				4	2	18	67	19		3	
Conyza bonariensis						11		14		3	
Lopholaena coriifolia				2	7	23	1	10			
Species Group 26											
Burkea africana			2	8	69	37	80	35	5		
Eragrostis gummiflua			2	6	18	17	16	32	2	1	
Oldenlandia herbacea				2	34	30	9	30	5	5	
Ochna pulchra				8	36	18	70	17			
Brachiaria nigropedata			2		31	4	41	13		4	
Schizachyrium jeffreysi				1	23	5	53	13			
Andropogon chinensis				1	28	39		10			4

Species Group 27											
Felicia muricata				11	1	13	3	18			
Schizachyrium sanguineum				27	40	52	43	14			
Fadogia homblei			2	42	35	54	19	11			
Loudetia simplex				84	59	41	3	10	2		
Eragrostis racemosa				83	20	49	17	10	2	3	
Species Group 28											
Setaria sphacelata	9	33	2	19	17	74	43	25	7	3	
Species Group 29											
Aristida junciformis	55		2		5	33	9	12		1	
Species Group 30											
Fluegga virosa			5					4	30	7	2
Schotia brachypetala			9		1			1	27	5	
Enneapogon scoparius					8		4	6	27	9	
Bridelia mollis			2		5			3	25	1	
Scolopia zeyheri			7						23	3	
Zanthoxylum capense			9		1	5			23		
Kirkia acuminata					3			4	21	3	2
Ximenia americana									21		8
Clerodendrum glabrum			5		3	8		6	21		
Spirostachys africana			2						14	5	
Setaria pumila					1			5	14	4	
Psiadia punctulata									14		
Schistostephium heptalobum			5	4					14		
Obetia tenax			2						14		
Lippia rehmannii					3			3	11		
Hermannia floribunda									11	1	
Jatropha zeyheri					7		5		11	1	
Cassine aethiopica									11	1	
Tephrosia species					4			2	11	1	
Aloe marlothii					9	3		2	11	3	
Adenia glauca					3				11		
Euphorbia cooperi					1				9		
Euphorbia schinzii					1		1		7		
Species Group 31											
Tagetes minuta	9		2	2	3	8	7	10	11	5	
Species Group 32											
Sida cordifolia			2		3	4	20	22	25	8	2
Indigofera species					4		20	2	14	1	4
Species Group 33											
Eragrostis curvula				7	7	13	11	22	23	8	
Species Group 34											
Pseudolachnostylis maprouneifolia				1	36	6	3	5	23		
Commelina erecta				1	17	15	34	8	21	9	
Lannea discolor				3	51	25	36	15	18		
Elephantorrhiza burkei				3	40	36		7	18		4
Gardenia volkensii			5	1	15	11		4	18	4	

Diplorhynchus condylocarpon			1	56	5	9	8	14		
Pterocarpus rotundifolius				25	9	1	17	14		
Rhoicissus revoilii			4	37	21		7	14	7	
Combretum zeyheri				25	12	44	20	14	1	
Strychnos madagascariensis			1	15			4	14		
Species Group 35										
Vitex rehmannii		5	16	41	46	51	22	25		
Asparagus transvaalensis			24	4				23		
Trachypogon spicatus		9	59	21	51	43	14	16	1	
Ozoroa paniculosa		2	10	40	28	32	12	11		
Tephrosia longipes			36	35	5	14	15	11	8	
Species Group 36										
Dombeya rotundifolia		14	3	12	21	39	13	71	7	
Euclea natalensis		12		16	4	34	8	36	9	
Acacia caffra		16	10	5	26	6	16	36	1	
Berchemia zeyheri		12	1	1	1		2	34		
Mimusops zeyheri		19		7	19		2	32	1	
Olea europaea		30			2		2	30		
Euphorbia ingens		26		2				27	1	
Combretum molle		12	12	87	60	55	21	27	1	
Brachylaena rotundata		14	8	11	15			23	1	
Pellaea calomelanos		47	42	49	16	14	7	23		
Cussonia paniculata		12	1	2				21		
Croton gratissimus		19		24	4	1	4	21	1	
Englerophytum magalismontanum		14	36	66	35	1	4	21	1	
Diospyros whyteana		58	1	7				16		
Vangueria infausta		14	49	39	42	2	5	16		
Rhoicissus tridentata		16	6	5	8		2	16	1	
Ficus thonningii		21	1	2	4		4	14		
Maytenus undata		33	2	3	4			14		
Heteropyxis natalensis	9	19	11	15	22		3	14	1	
Faurea saligna	9	16	13	13	42	4	10	11		
Species Group 37										
Ehretia rigida		9		9		7	7	9	33	
Sporobolus ioclados							8		30	
Acacia erubescens							7	2	29	4
Achyropsis avicularis						2		2	20	
Sporobolus fimbriatus						3	2	7	16	
Acacia erioloba							2		15	
Acacia burkei						2	4		15	
Phyllanthus reticulatus									15	
Eragrostis trichophora			1				2	2	15	
Brachiaria eruciformis									13	
Justicia protracta						4		5	13	2
Tephrosia capensis				1			2	7	12	
Jasminum breviflorum									12	
Gymnosporia polyacantha		9		1				7	11	
Hibiscus pusillus						3		2	11	
Cyphostemma cirrhosum									11	
Kalanchoe lanceolata				1		7			11	
Blepharis integrifolia				1					11	2
Opuntia species									11	

Species Group 38									
Carissa bispinosa	5				3		21	21	
Combretum hereroense			3		1	2	18	20	
Kalanchoe rotundifolia	2	2	4	3	3	1	11	18	
Elaeodendro transvaalensis	5				3		11	15	
Sida dregei			1	3	3	2	16	12	
Species Group 39									
Solanum panduriforme		2	5	8	2	21	25	38	
Chamaecrista comosa						10	5	16	
Species Group 40									
Grewia flavescens			8	4	55	24	36	43	8
Euclea undulata					13	2	9	29	
Aloe greatheadi v davyana			2		25		2	20	
Sida alba					15			11	
Solanum coccineum					26		2	11	
Species Group 41									
Gymnosporia buxifolia			5	14	8	7	39	18	2
Euclea crispa	9	2	5	22	3	23	57	13	
Asparagus laricinus			3	10		3	2	13	
Species Group 42									
Terminalia sericea			16	5	76	55	11	18	
Lippia javanica		3	15	39	19	30	21	13	
Species Group 43									
Commelina africana	5	42	42	16	69	19	5	16	
Species Group 44									
Rhus leptodictya	12		9	19	13	9	55	21	
Pappea capensis	19		3	4	3	4	68	15	
Asparagus setaceus	19		10	2		2	2	12	
Diospyros lycioides	12		3	12	12	7	11	11	
Species Group 45									
Enneapogon cenchroides			3			3	5	1	77
Melhania acuminata									67
Achyrantes aspera	2						2	1	63
Monechma debile									54
Hibiscus micranthus									52
Corbichonia decumbens									46
Urochloa panicoides									44
Bothriochloa radicans									42
Eragrostis species									42
Tephrosia purparascens									40
Seddera capensis									38
Carex austro-africana									33
Melhania rehmannii									31
Aristida rhiniochloa			6			3		1	29
Momordica repens									25
Aptosimum lineare									25
Tribulus species								1	25

Setaria verticillata								1	25
Cenchrus ciliaris							2	3	23
Indigofera nigromontan									21
Heliotropium steudneri									21
Leucas glabrata									21
Giseki africana									21
Commiphora africana							2	1	21
Boscia foetida									20
Sida chrysantha					8			3	19
Ehretia amoena									19
Geigeria ornativa							2		19
Dipcadi glaucum									15
Lycium cinereum								9	15
Dicoma tomentosa									15
Indigofera alternata									15
Blechnum australe									13
Abutilon austro-africanum								5	13
Mariscus rehmannianus									13
Chenopodium album									13
Asparagus nelsii									13
Cissus fragilis									13
Clerodendrum ternatum									13
Ceratotheca triloba						4		5	10
Geigeria burkei			1	7			2		10
Dicliptera fruticosa									10
Ornithoglossum species									10
Digitaria velutina									10
Ledebouria viscosa									10
Species Group 46									
Tragus berteronianus						8		11	54
Pupalia lappacea							2	11	46
Acacia mellifera					2	2	7	21	21
Euclea divinorum						2		15	21
Justicia flava					2		5	29	15
Combretum imberbe	2						5	12	13
Species Group 47									
Acacia nigrescens						2	30	16	69
Pavonia burchellii	2					1	21	12	27
Commiphora mollis			3			3	14	3	21
Sclerocarya birrea			2		2	4	21	4	17
Boscia albitrunca					1		14	4	17
Acacia robusta	5					2	14	5	15
Species Group 48									
Grewia bicolor			5			14	16	34	77
Grewia flava	2	1	2	1	4	15	39	36	75
Aristida adscensionis		2	2	2	6	13	5		73
Aristida congesta s barbicollis		2		3		26	5	18	40
Urochloa mosambicensis						10		11	19

Species Group 49										
Kyphocarpa angustifolia			4		47	3		18	67	
Ruellia patula					18		2	3	38	
Pogonarthria squarrosa		4	5	8	31	45	11	7	23	
Peltophorum africanum			3	3	20	23	23	15	19	
Commelina benghalensis			2		12	2	5		13	
Species Group 50										
Grewia monticola			11	3	9	10	30	18	58	
Panicum maximum		1	25	9	28	38	73	65	56	
Combretum apiculatum			19	9	19	27	48	18	38	
Waltheria indica		3	17	3	74	33	16	18	35	
Phyllanthus parvulus		8	33	3	43	6	2	1	19	
Asparagus suaveolens		6	30	21	23	6	9	25	19	
Digitaria eriantha			44	19	81	63	23	33	17	
Species Group 51										
Melinis repens s repens	7	21	55	41	7	69	28	11	50	
Heteropogon contortus	2	40	20	37	46	38	21	9	15	
Species Group 52										
Jamesbrittenia aurantiaca								4		80
Senecio apiifolius								1		80
Salvia repens								3		80
Falckia oblonga								3		80
Berkheya radula								3		80
Scilla dracomontana								1		60
Aspilia species										60
Dichanthium annulatum					1	2		3	6	60
Crotalaria sphaerocarpa					2	2		1	2	20
Leucas neuflizeana					2				4	20
Cullen holubii					1					20
Litogyne gariepina								1		20
Mariscus species										20
Nesaea schinzii								4		20
Species Group 53										
Acacia nilotica					4	2	2	12	6	60
Acacia tortilis					5	4	7	49	75	20
Chloris virgata						2		30	54	20
Species Group 54										
Rhus pyroides	2		1	8	3	12	7	17		20
Monsonia angustifolia			3	3	3	10				20
Schmidtia pappophoroides			7		2	22	21	25	25	20
Schkuhria pinnata			2		2	11	9	5	31	20
Eragrostis rigidior			3	2	7	35	23	26	33	20
Acacia karroo				3	3	16	27	40	25	20
Species Group 55										
Solanum delagoense					14			4	63	20
Dichrostachys cinerea			5	5	48	35	32	66	67	20
Achyranthes aspera	2	1	2	5	26	4	9	30	2	20
Evolvulus alsinoides		2	5	3	72	6	2	1	8	20
Hibiscus cannabinus					19			4		20

Portulaca pilosa							19					20
Hermbstaedtia linearis							14				40	20
Eragrostis lehmanniana				1	2	7	21	19	14	18	10	20
Species Group 56												
Aristida congesta s congesta				7	35	23	83	65	22	30	8	20
Ziziphus mucronata			5		10	10	4	21	80	41		20
Vernonia poskeana			2	2	16	6	61	16		3	2	20
Species Group 57												
Themeda triandra				56	24	57	46	16	18	11	2	60
Species Group 58												
Setaria incrassata	9	67	2							4	2	80
Senecio inornatus		67				2		4		4		20
Species Group 59												
Aristida bipartita	36									3		80

4.5 References

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CHAPTER 5
IDENTIFICATION AND DESCRIPTION OF ECOZONES FOR TOURISM WITHIN THE WATERBERG BIOSPHERE RESERVE

5.1 Introduction

There are many management applications for vegetation mapping using predictive models and Geographical Information Systems (GIS) (Tiwari *et al.* 1996). Lechmere-Oertel & Cowling (1999) showed, for example, how the boundary between different biomes can be predicted within a GIS environment and the implication thereof for management and monitoring under South African conditions. The value of using GIS as a tool for the identification of homogenous natural vegetation units on a larger scale can therefore not be underestimated (Fairbanks, 2000).

These large natural units that make up the environment are called ecological zones, or "ecozones". An ecozone is a large natural unit, controlled by a set of common processes, mostly climatic, and is dominated by life-forms with similar physical adaptations to those processes (IUCN, 1992). Gertenbach (1983) used several environmental parameters to zonate the Kruger National Park, South Africa, into 35 landscapes. A landscape was defined as an area with a specific geomorphology, climate, soil and vegetation pattern together with the associated fauna. These landscapes were later combined to produce larger tourism ecozones, providing tourists visiting the park with useful information regarding the environment (Jacana, 1997).

Properties of soils often determine the nature of vegetation (Brady & Weil, 1999). White (1995) described the term catena as the suite of contiguous soils extending from hill top to valley bottom in undulating landscapes, restricted to a single climatic zone, although uniformity of parent material was not a prerequisite. Jacana (1997) showed illustrated examples of these catenas within the Kruger National Park on specific soils underlied by the specific geological formation, with the associated vegetation. Furthermore, Bredenkamp & Brown (2001) stated that any spatial or temporal changes in the physical environment (e .g. change in soil condition from sand to clay etc.) would affect the plant species composition, performance and success of the vegetation. Catenas are therefore not only restricted to soils within a landscape, but may reflect the gradients between the plant communities associated with the soil types. Using catenas as vertical sections through a larger landscape, may thus be very useful in showing the contiguous soils, geology and plant communities.

The aim of this chapter is to identify and map relatively homogenous ecozones for tourism within the Waterberg Biosphere Reserve, using different environmental parameters with associated plant communities as basis for identification, as also shown by Jacana (1997). Catenas of the ecozones are also produced to show the specific sequences of geology and soils and how the major plant communities types identified in Chapter 4 fit into each specific ecozone. These ecozones should also provide useful information to tourists visiting the Waterberg Biosphere Reserve, as well as information to managers of parks and nature reserves.

5.2 Methods

5.2.1. Field surveys

Field surveys were conducted throughout the Waterberg Biosphere Reserve to identify and correlate specific characteristics of landscapes with known environmental parameters. The surveys involved the identification of specific plant communities previously described within the Waterberg Biosphere Reserve, and correlation of plant communities with soil, geology, climate, geomorphology and altitude. Most of the parks and nature reserves within the Biosphere Reserve were visited as well as some reserves outside the Biosphere Reserve, where similar landscapes occur. Localities where field surveys were conducted include the following:

D'Njala Nature Reserve
Doorndraaidam Nature Reserve
Emaweni Game Lodge
Entabeni Private Game Reserve
Jobedi Game Lodge
Kwalata Game Lodge
Mabalingwe Game Lodge

Mabula Game Lodge
Marakele National Parks
Masebe Nature Reserve
Nylsvley Nature Reserve
Sambane Game Lodge
Slangkuil Game Farm
Suikerboschplaat Game Farm
Welgevonden Private Game Reserve
Wonderkop Nature Reserve

The field surveys provided a valuable basis for understanding the geology and soils, vegetation patterns and climate of the study area, and were extremely useful in the selection of mapable ecozones. The parameters further provided the basis for the identification of the ecozones.

5.2.2 GIS Mapping

Maps are usually created in a Geographical Information System. Predictive vegetation maps can be extrapolated over large areas of remote terrain, thereby reducing the survey effort for checking predictions, and can be used for monitoring and predicting vegetation change in response to global change (Lechmere - Oertel & Cowling, 1999).

The identification of ecozones was done after the field surveys, using digital data from ENPAT (2000) and a digitized geological map from Jansen (1982). Boundaries of geological formations were digitized from a 1:1 000 000 geological map produced by Jansen (1982), within the boundaries of the Biosphere Reserve. The map was valuable for the identification of the ecozones, and was used as an overlay theme with the soils when identifying the ecozones. Other information obtained from the digital database ENPAT (2000), to identify ecozones, were altitude contours and climate. After the identification of the ecozones, an ecozone map was produced in a GIS program, Arcview. The map and a detailed description of ecozone identification and ecozone environmental characteristics are included in the following section.

5.3 Results and Discussion

5.3.1 Identification of ecozones

Figure 5.1 represent the ecozone map of the major part of the Waterberg Biosphere Reserve, while figure 5.2 represent the ecozone map, on a smaller scale, of the Nylsvley Nature Reserve. Different environmental parameters were used to identify and describe the ecozones within the biosphere reserve. Six different ecozones were identified as described in the following section. The high altitude ecozone shows two variations. The Nylsvley Nature Reserve was included in the ecozone identification, although not being part of the Waterberg Biosphere Reserve yet. The Reserve will probably be included into the Biosphere Reserve in the near future.

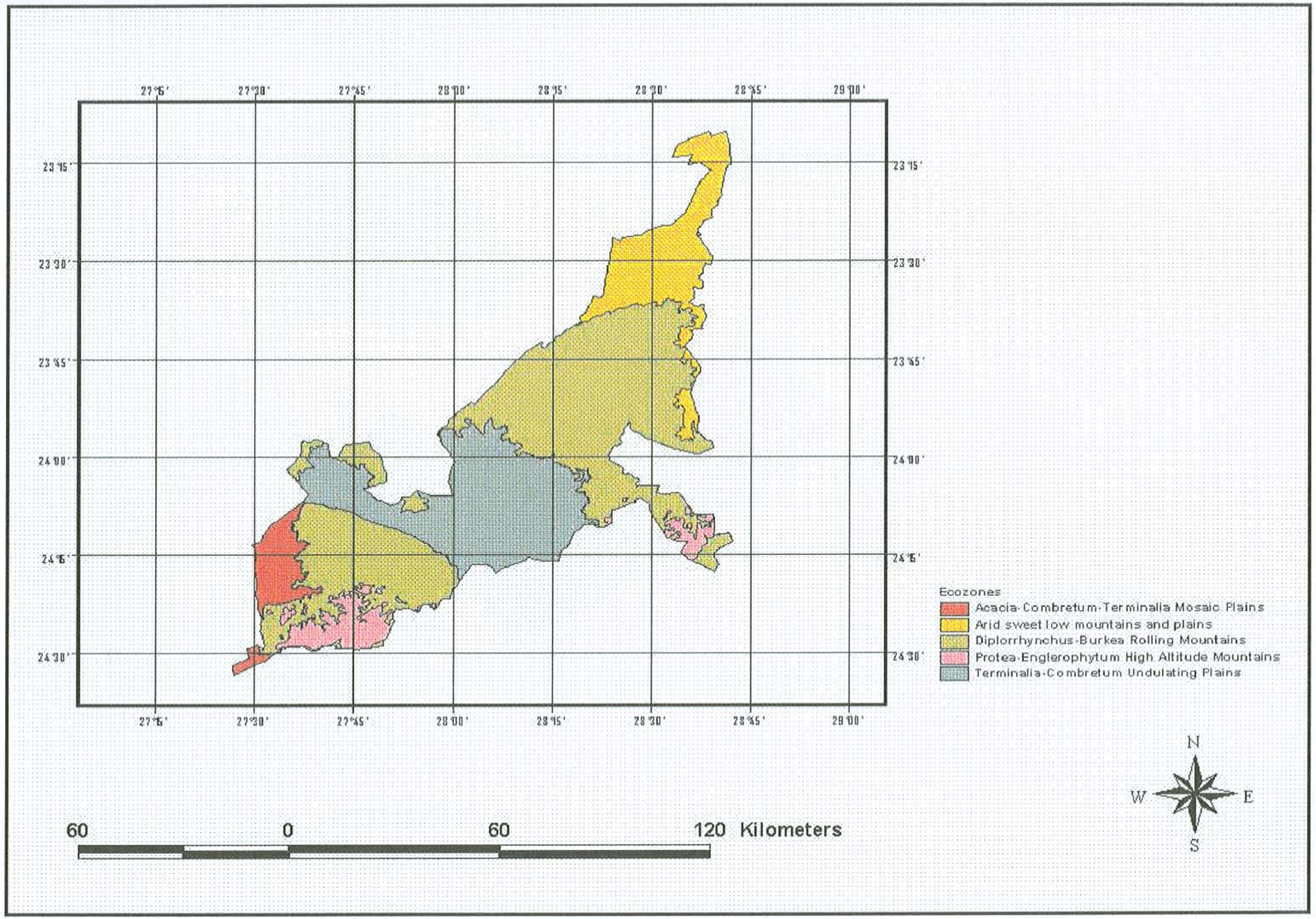


Figure 5.1 The major Ecozones of the Waterberg Biosphere Reserve

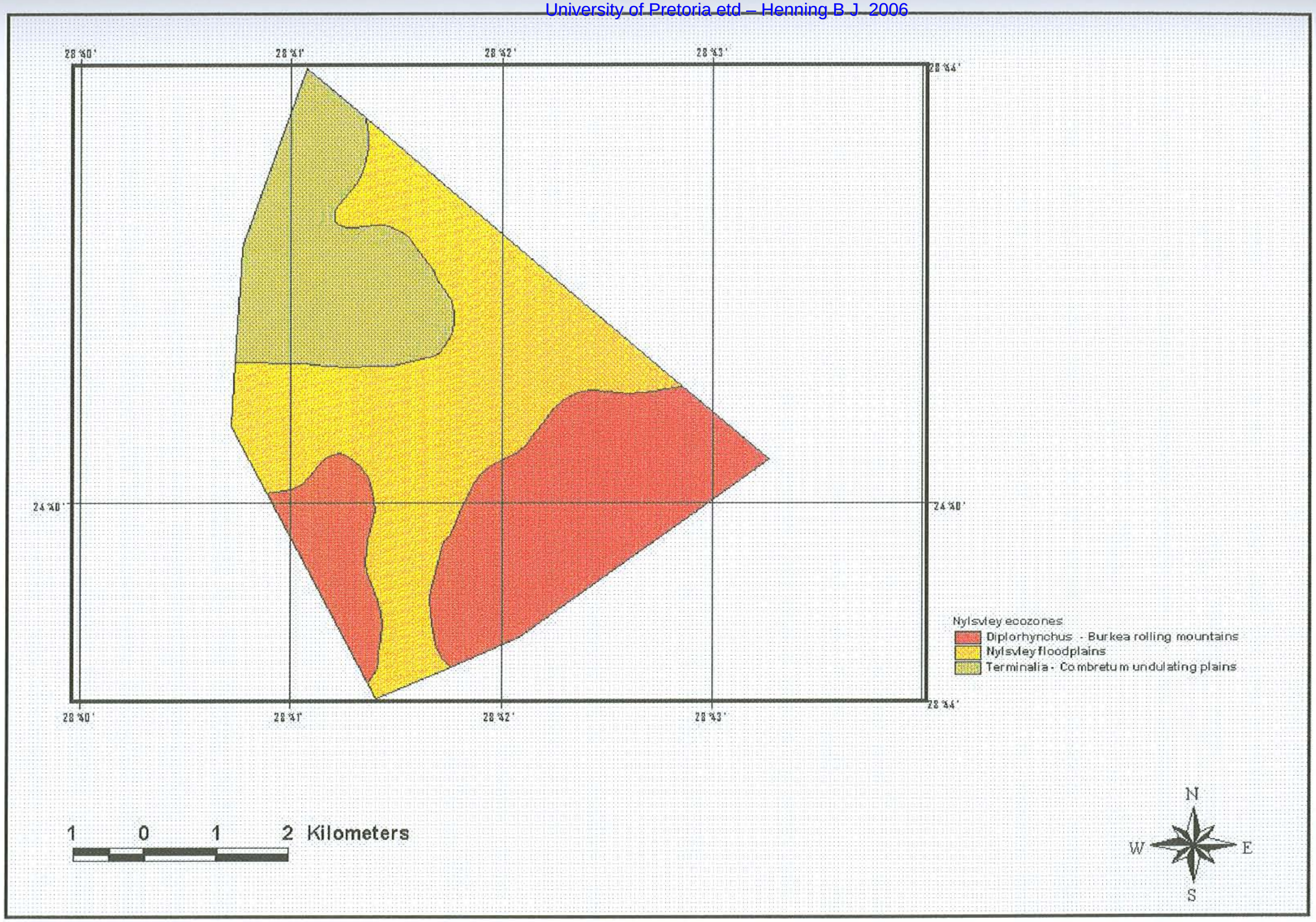


Figure 5.2 The Ecozones within the Nylsvley Nature Reserve

5.3.2 Description of ecozones

5.3.2.1 The *Protea-Englerophytum* High Altitude Escarpment Ecozone

This ecozone were identified as areas of altitude higher than 1500 m. The general climate at such altitudes is much cooler and the major determining factor is thus climate. Higher rainfall and frequent mist (Westfall, 1981) occurring in the upper reaches of this ecozone contribute largely to the vegetation structure, mostly open woodland and closed grassland. Gertenbach (1987) describes rainfall as the single most important component of climate determining vegetation patterns. The plant communities as previously described in Chapter (Ch.) 4 represented in this ecozone are the following:

- The *Fuirena pubescens-Andropogon huilensis* Sponge major plant community
- The *Podocarpus latifolius-Diospyros whyteana* Kloof major plant community
- The *Protea caffra-Loudetia simplex* cool slopes and escarpment crest major plant community
- The *Cynodon dactylon-Dichrostachys cinerea* old fields major plant community

The high altitude mountain ecozone occurs dominant in two localities, namely the in the Kransberg Mountains of the Marakele National Park in the southwest of the Waterberg Biosphere Reserve, and in the Entabeni Game Reserve in the eastern part of the study area. The vegetation varies between the two areas as indicated on the catenas (Fig. 5.3 a, b.) of the vegetation.

a. Variation 1. Vegetation of the Marakele National Park

These high altitude areas are dominated by the *Protea caffra-Loudetia simplex* community (Van Staden, in prep.) on cooler southern and eastern rocky slopes (50% rockiness), on shallow soils of the Mispah soil type. This plant community dominates the ecozone at altitudes of between 1500 - 1700m. The warmer northern and western slopes, with similar rockiness and soils, are dominated by *Englerophytum magalismontanum*, similarly described by Newberry (1998) as the *Englerophytum* *magalismontanum-Mimusops zeyheri* short open woodland. The dominant vegetation of the highest altitudes between 1700 - 2100m is mostly short closed grassland [*Andropogon schirensis-Dicoma anomala* community described by Van Staden (in prep.). These grasslands occur in areas where frequent mist occurs and forms part of Acock's (1988) North-Eastern Mountain Sourveld. Coetzee *et al.* (1981) described the grasslands as rare, only represented in areas where the conservation status is high, such as in the Marakele National Park (a core zone of the Waterberg Biosphere Reserve). Bushclumps of isolated forest occur within this plant community (Van Staden, in prep.). Another vegetation type of North Eastern Mountain Sourveld, replaced by the grassland on the upper reaches, occur in this ecozone, namely inland tropical forests. These forests, which form part of the Afro-Montane element of Southern Africa (Coetzee *et al.* 1981), occur in the moist ravines of the Waterberg escarpment and represent the *Podocarpus latifolius-Diospyros whyteana* Kloof major plant community [Chapter (Ch.) 4]. Within this ecozone, the mountain range sometimes forms low-lying valleys where the Matlabas- , Mamba - and Sterkstroom Rivers originate from the shallow submerged marshy areas or sponges (The *Fuirena pubescens-Andropogon huilensis* Sponge plant community). The sponges are sensitive areas, yet play an important role in providing habitats to specific birds and mammals (see Chapter 7). Figure 5.3 shows a typical catena of the plant communities in the landscape, while Figure 5.5 a shows an example of the high altitude areas in the Marakele National Park.

b. Variation 2. Vegetation of the Entabeni Game Reserve

Newberry (1998) described the dominant vegetation community as the *Englerophytum magalismontanum-Mimusops zeyheri* short open woodland, which falls within the *Protea caffra-Loudetia simplex* cool slopes and escarpment crest major plant community (Ch. 4), occurring on shallow Mispah soils, at altitudes between 1500 and 1700 metres (Fig. 5.5b). The escarpment at Entabeni Game Reserve forms rocky crests at these altitudes (Fig. 5.4). Isolated patches of this ecozone occur west of the Entabeni Game Reserve and represent this major plant community. However, at altitudes of 1500 m a large plateau forms within the ENR where the soils are somewhat deeper. Newberry (1998) described two communities on the plateau namely the *Protea caffra-Gnidia capitata* low open woodland occurring on Avalon soils; and the *Hyparrhenia hirta-Cynodon dactylon* closed grassland community dominated by clovelly soils. The latter community represents the *Cynodon dactylon-Dichrostachys cinerea* old fields and disturbed areas plant community, while the former represents the dominant *Protea caffra-Loudetia simplex* cool slopes and escarpment crest community. Coetzee *et al.* (1981) stated that these old fields are quite common disturbed grassveld patches, and game in the Reserve often heavily grazes these patches, especially after fires. Figure 5.3 b shows the high altitude areas in the Entabeni Game Reserve that forms part of the ecozone.

The dominant geomorphology of the high altitude mountain ecozone is escarpment with ravines, valleys and steep slopes. Plateaus occur on the upper side of the escarpment, as described in the Entabeni Nature Reserve. The geological formations include sandstone of the Sandsriviersberg formation (Marakele National Park) and Mogalakwena formation (Entabeni Nature Reserve and isolated patches). The plant diversity within this ecozone is mostly dependent on ravines, rockiness and temperature - radiation moisture regimes (Coetzee *et al.* 1981).

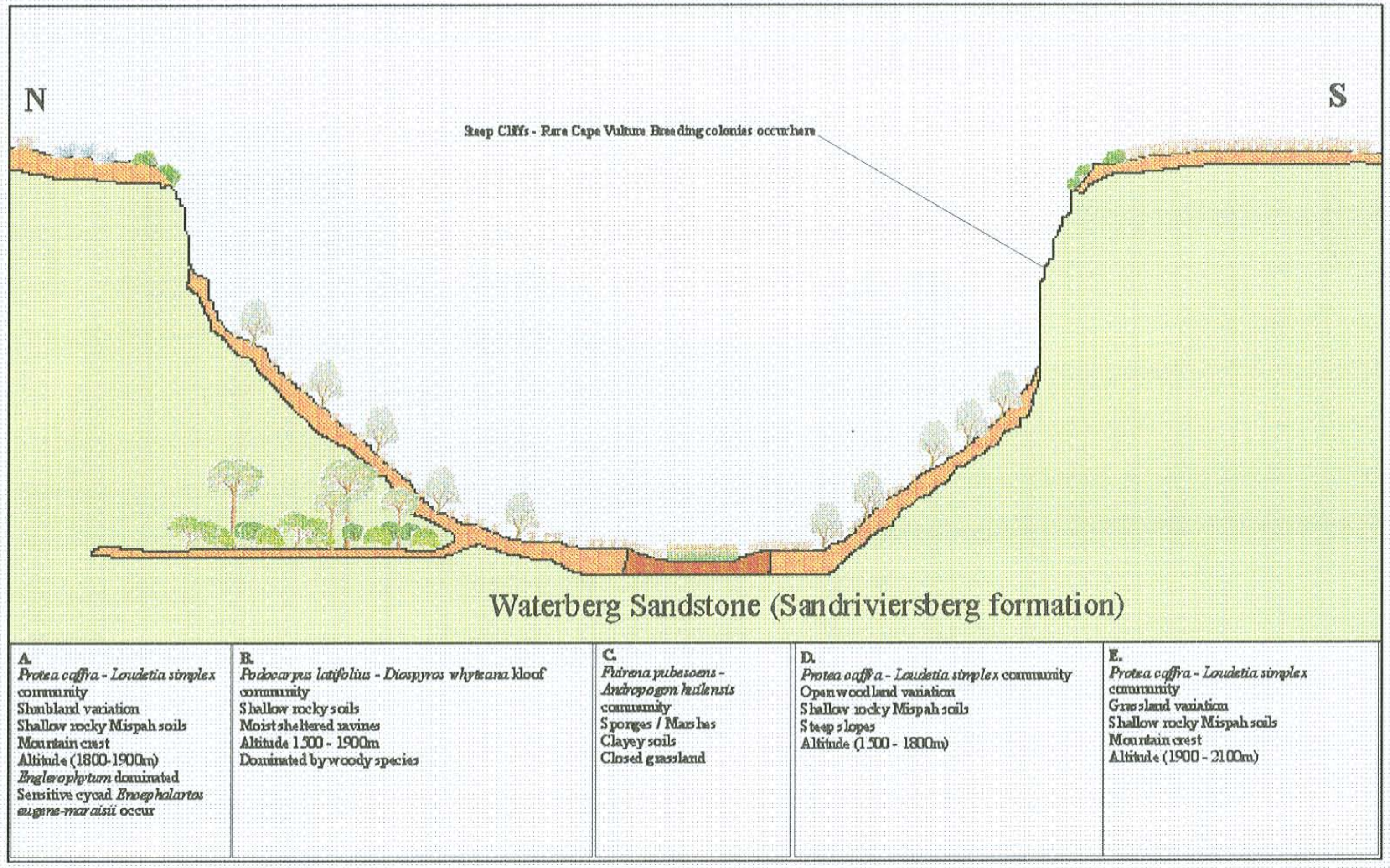


Figure 5.3 Catena of the High Altitude Mountain Ecozone in the Marakele National Park

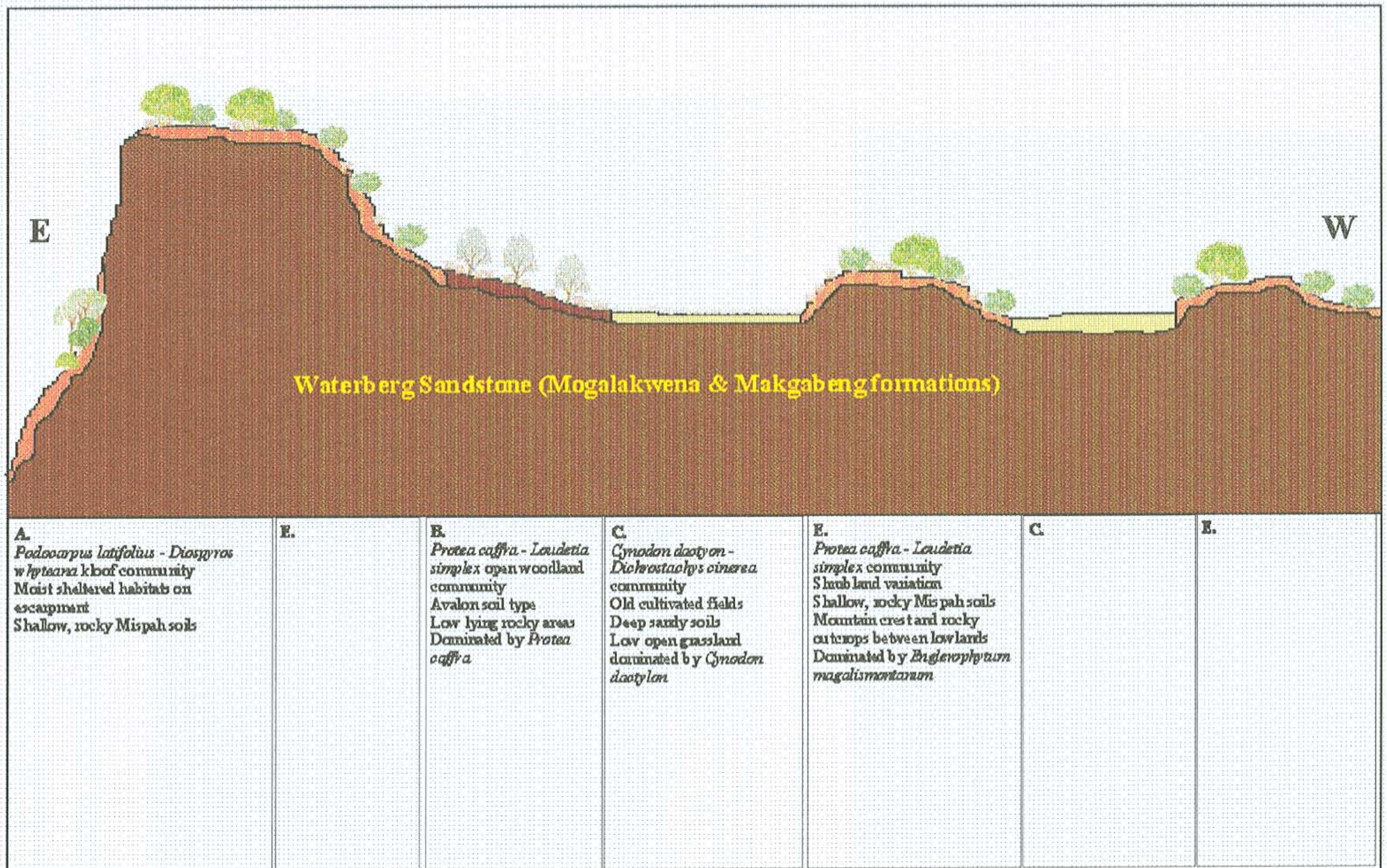


Figure 5.4 Catena of the Entabeni Game Reserve representing a variation of the High Altitude Mountain Ecozone

a.)

b.)

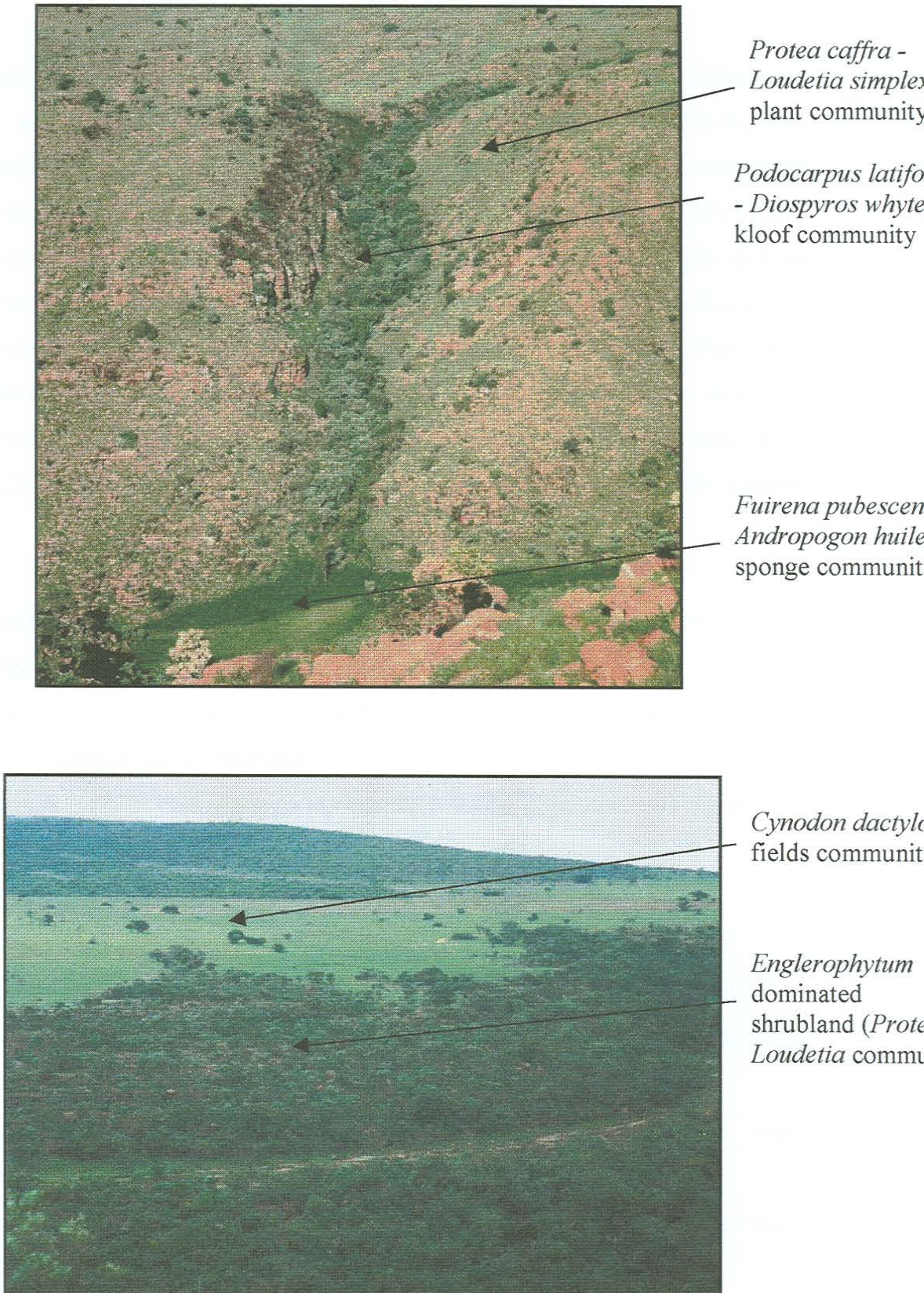


Figure 5.4. The *Protea-Englerophytum* High Altitude Escarpment Ecozone, showing the major plant communities occurring in the two variations, namely the Marakele National Park (a) and Entabeni Game Reserve (b).

5.3.2.2 *Diplorhynchus-Burkea* Rolling Mountains Ecozone

The *Diplorhynchus-Burkea* Ecozone is the most dominant ecozone within the Waterberg landscape. The ecozone was identified based on geology and soils. The geology underlying the vegetation is Waterberg sandstone of the Sandriviersberg and Mogalakwena formations, lower than 1500 metres altitude (Fig. 5.6). Callaghan (1987) described these two formations together based on sedimentary style, and he even submitted a proposal to the SACS working group for the Waterberg and Soutpansberg Groups in which the formations are considered a single formation. Diabase and dolerite dykes also frequently occupy topographic depressions or rifts in the sandstone formations. The geomorphology of the area is classified as table-lands (ENPAT, 2000). The following major plant communities occur within this ecozone (Ch. 4):

- The *Diplorhynchus condylocarpon-Englerophyton magalismontanum* rocky slope major plant community
- The *Burkea africana-Setaria sphacelata* undulating plains, footslopes, terraces and plateaus major plant community
- The *Terminalia sericea-Eragrostis pallens* deep sands of the lowlands major plant community
- The *Protea caffra-Loudetia simplex* cool slopes major plant community
- The *Phragmites australis- Persicaria serrulata* vlei major plant community
- The *Podocarpus latifolius-Diospyros whyteana* kloof major plant community
- The *Cynodon dactylon-Dichrostachys cinerea* old fields and disturbed areas major plant community
- The *Dombeya rotundifolia-Panicum maximum* sweet rocky major plant community
- The *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria major plant community

Well-known places where this ecozone occurs include the Welgevonden Game Reserve, Marakele National Park, Shambala Private Game Reserve, Lapalala Wilderness Area, Kwalata Game Lodge, Entabeni Game Reserve (Mmadikiri section), Nylsvley Nature Reserve, Masebe Nature Reserve, Touchstone Game Lodge and Mokolo Dam Nature Reserve

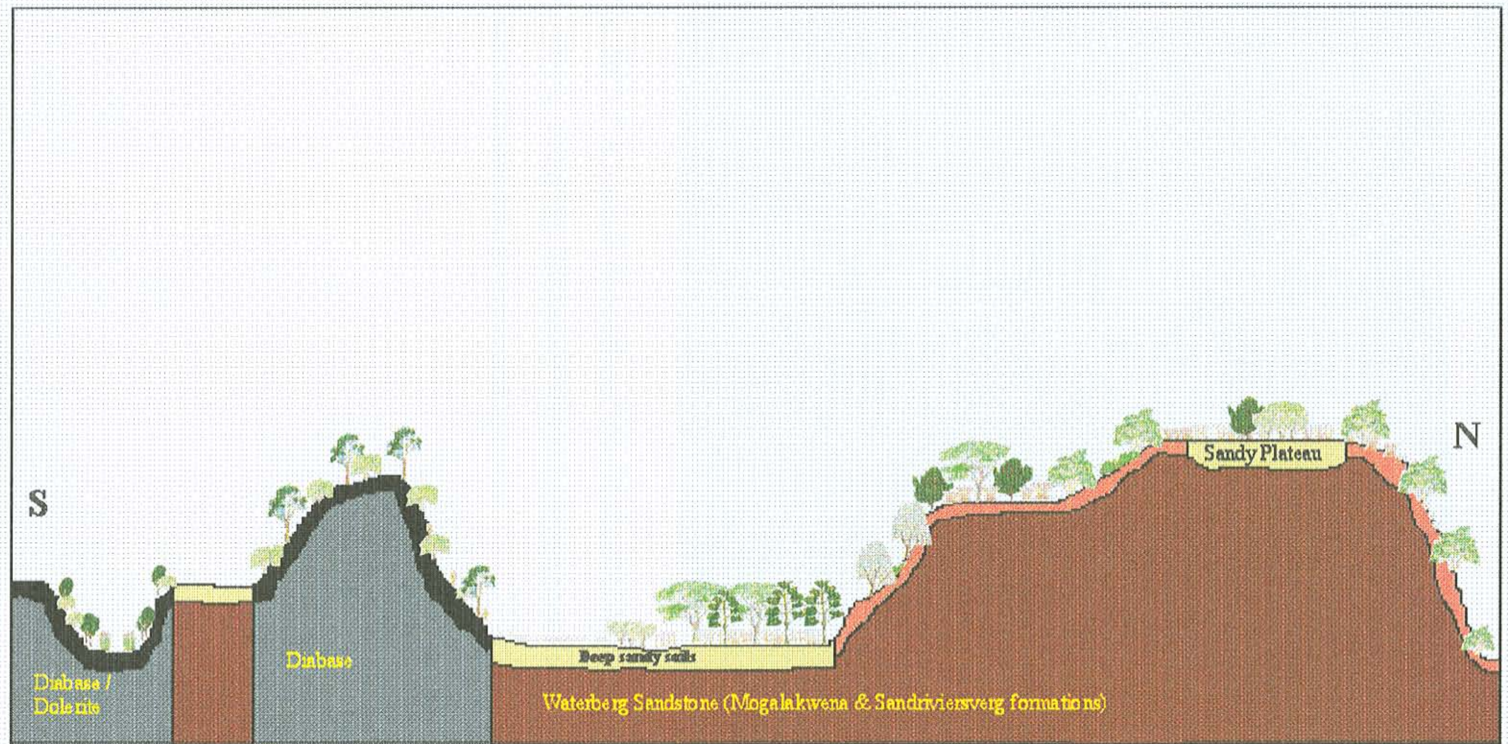
The plant communities are correlated to the landscape geomorphology, aspect and rockiness. The warm northern and western slopes are dominated by the *Diplorhynchus condylocarpon-Englerophyton magalismontanum* rocky slope community, occuring on Mispah and Glenrosa soil types on rocky slopes. It is classified by Coetzee *et al.* (1981), as warm moderate deciduous broadleaf sour bushveld. The cooler southern and eastern slopes consist of deciduous broadleaf species such as *Faurea saligna, Heteropyxis natalensis* and *Protea caffra,* and the microphyllous *Acacia caffra* sometimes dominating southern slopes (Coetzee *et al.* 1981). These species form part of the *Protea caffra-Loudetia simplex* cool slopes community. Although only occurring in small isolated patches, the *Podocarpus latifolius-Diospyros whyteana* community occurs in isolated ravine areas among these slopes, in places such as the Emaweni Game Lodge and Shambala Private Nature Reserve.

The foothills, terraces and rocky plateaus of the mountainous slopes represent the habitat of the *Burkea africana-Setaria sphacelata* community. *Burkea africana* shows a high affinity to these warmer, lower lying communities in rocky places. In some places, Coetzee *et al.* (1981) noted that stands of *Burkea africana* can be almost pure, with *Combretum apiculatum* dominating terraces with conglomerates as substrate. This plant community sometimes forms a mosaic with the *Terminalia sericea-Eragrostis pallens* deep sands community of the lowlands and sandy plateaus. The habitat of this community is leached, sandy soils dominated by *Terminalia sericea* and *Eragrostis pallens.* The sandy areas of the lowlands and plateaus also provide the habitat for the *Cynodon dactylon-Dichrostachys cinerea* old fields and disturbed areas community, typical of low lying areas within the Waterberg, yet providing an important habitat for several antelope grazing species. Both primary and secondary old fields occur as previously discussed.

The nutritionally enriched soil types, described by Coetzee (1975), as *Acacia caffra* savannas on diabase and in sheltered valleys, form the substrate on which the sweet rocky *Dombeya rotundifolia-Panicum maximum* community occurs. These areas occur as dolerite and diabase dykes between slopes, or as rocky outcrops, such as on Tafelkop in the Emaweni Game Lodge, and the western mountainous part of Entabeni Nature Reserve. Another sweet bushveld plant community occurring in this ecozone is the *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria, mostly occurring in low lying areas, plateaus and terraces, where the soils are deeper, with a clayey layer underneath the sand. These termitaria provide useful grazing, shelter and nesting sites to birds and animals from the otherwise low value grazing in these areas.

The wetter zones along rivers and dams within the ecozone represent the *Phragmites australis-Persicaria serrulata* vlei community. This vegetation type is well represented throughout the ecozone in the Emaweni Game Lodge, Welgevonden Game Reserve and Marakele National Park.

Figure 5.6 shows the catena of the typical landscape geomorphology, geology, soils and major plant communities, while Figure 5.7 shows a photograph of the rolling mountains occurring in this ecozone.



A. *Dombeya - Panicum* sweet community Diabase / Dolerite dyke Clayey soils Along rivers / dams *Phragmites - Persicaria*	B.	A. *Dombeya - Panicum* community Rocky diabse outcrop Clayey - loam soils (Hutton)	B. *Cynodon - Dichrostachys* community Old fields - Secondary and primary Lowlands	C. *Terminalia sericea - Eragrostis pallens* Community Deep sands (Clovelly) Low lying valleys and seepage lines	D. Cool southern slopes community *Protea - Acacia caffra* dominated Shallow	E. *Burkea - Setaria* community Shallow rocky soils on terraces / foothills	G.	F. *Acacia - Panicum - Zisiphus* Termitaria Community Sandy soils on plateaus and terraces, with clayey layer underneath	G. *Diplorrhynchus - Englerophytum* community Warm northern slopes Shallow rocky Mispah soils Kloof vegetation

Figure 5.6 Catena of the *Diplorhynchus-Burkea* Rolling Mountains Ecozone

Figure 5.7 A typical example of the *Diplorhynchus-Burkea* Rolling Mountain Ecozone, showing *Burkea africana* (white arrow) and *Diplorhynchus condylocarpon* (yellow arrow) as the dominant species

5.3.2.3 *Terminalia-Combretum* Undulating Plains Ecozone

The *Terminalia-Combretum* Ecozone occurs in the valley in the Vaalwater area, stretching to the north to Melkrivier, and to the west, to just south of Mokolo Dam. The ecozone was identified according to the characteristic geomorphology of the area, although the underlying geology and soils determined the boundaries of this ecozone (Fig. 5.8). Van Rooyen & Bredenkamp (1996) described this area as the Mixed Bushveld Vegetation Type, and the boundaries of the mixed bushveld correlates closely to the geology boundaries. The underlying geology is of the Vaalwater and Cleremont formations. The Vaalwater formation differs from the Cleremont formation in being thicker, and representing a finer facies from a similar environment to the thinner Cleremont formation (Callaghan, 1987). The area representing this ecozone in the Nylsvley Nature Reserve is however underlain by granite, similarly described by Gertenbach (1983) as the mixed *Combretum / Terminalia sericea* woodland on granite. Conservation areas within the ecozone are Slangkuil Game Ranch, Jobedi Game Lodge, Mokolo River Nature Reserve, Nylsvley Nature Reserve and the southern parts of Kwalata Game Lodge. The typical geomorphology is moderately undulating plains in which the following major plant commuities occur (Ch. 4):

- The *Burkea africana-Setaria sphacelata* undulating plains major plant community
- The *Terminalia sericea-Eragrostis pallens* deep sands of the lowlands major plant community
- The *Cynodon dactylon-Dichrostachys cinerea* old fields and disturbed areas major plant community
- The *Dombeya rotundifolia-Panicum maximum* sweet rocky major plant community
- The *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria and encroached areas major plant community

Figure 5.8 shows a typical catena of the landscape. The low-lying areas are highly leached, with a high base status on Cartref and Clovelly soil types (Von Holdt, 1995). These areas are often totally dominated by the *Terminalia sericea-Eragrostis pallens* deep sand community, with *Terminalia sericea* often forming almost pure stands in the low lying areas and seepage lines. When these areas have a clayey layer underneath a sandy layer, the *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria community becomes more prominent. These termitaria have enriched soils with typical sweet bushveld elements like *Acacia* species, *Pappea capensis* and *Panicum maximum*. Game farms previously used for cattle farming often have the encroached variation of this major community, where *Dichrostachys cinerea* completely dominates, and often form impenetrable thickets. As described in Ch. 4, the low-lying sandy areas were previously used for crop cultivation, and therefore when abandoned, undergo successional stages. Variations of both primary and secondary old fields occur in the ecozone. The secondary old fields often have more woody species like *Terminalia sericea* and *Acacia karroo*, while the primary old fields form low, open grasslands, dominated by *Cynodon dactylon* and *Hyparrhenia hirta*.

The low lying areas underlain by diabase or dolerite, provide the habitat for the *Dombeya rotundifolia-Panicum maximum* sweet rocky community, although in this ecozone the rockiness is often not as high as in the *Diplorhynchus-Burkea* Rolling Mountains Ecozone. Soils of the Milkwood and Westleight soil forms often dominate and occurs along dykes that form small rivers and streams.

The undulating areas of the ecozone are the most rocky, and dominated by Mispah and Glenrosa soil types. These low-lying warm slopes are often dominated by *Combretum apiculatum* and *Pterocarpus rotundifolius* (Coetzee *et al.* 1981) and forms part of the *Terminalio sericeae-Combretetea apiculati* class described by Winterbach (1998). The typical undulating landscape can be seen in figure 5.9.

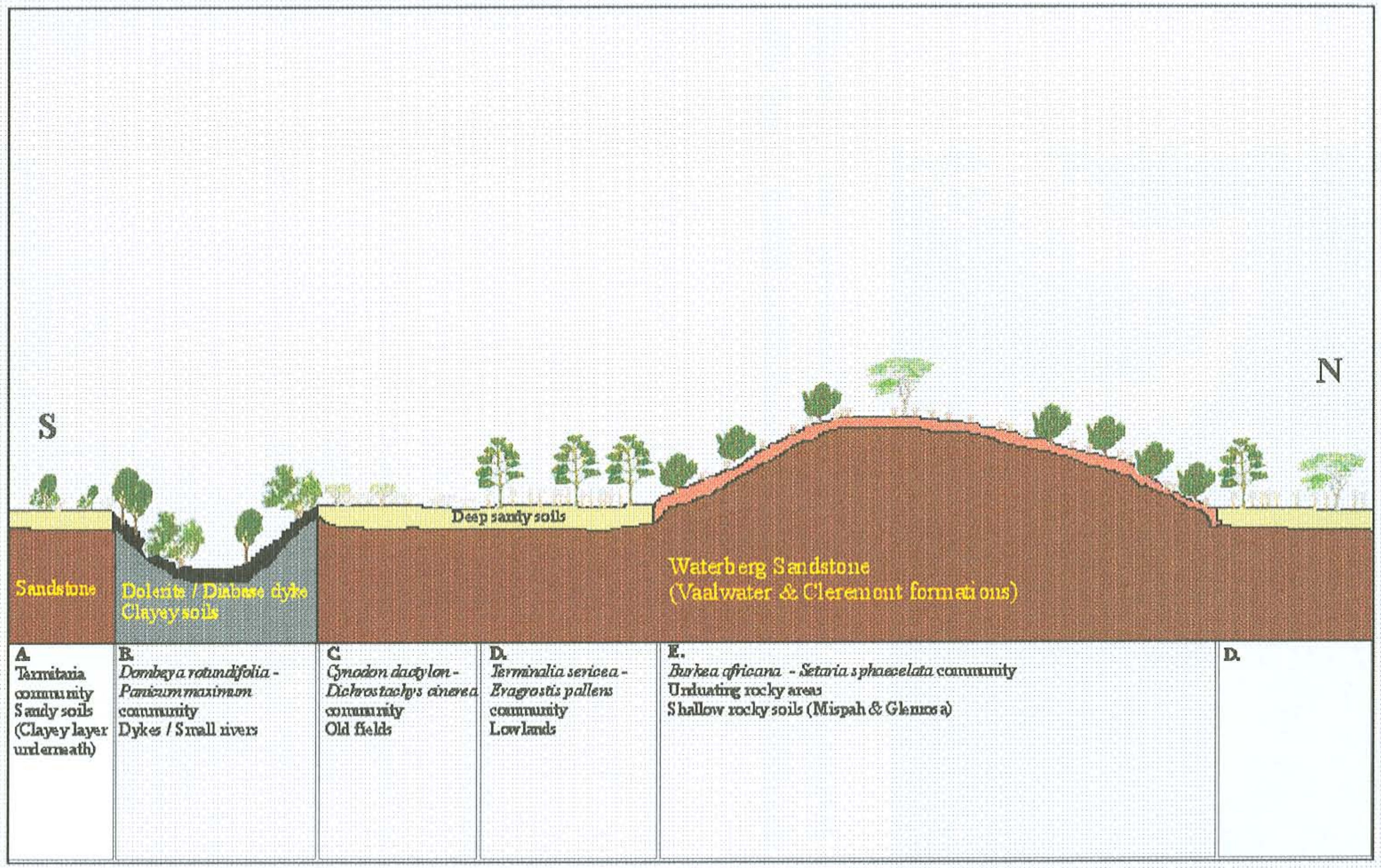


Figure 5.8 Catena of the *Terminalia-Combretum* Undulating Plains Ecozone

Figure 5.9. The *Terminalia-Combretum* undulating plains ecozone in the Vaalwater area showing typical undulating areas dominated by *Combretum apiculatum* (arrow)

5.3.2.4 *Acacia-Combretum-Terminalia* Mosaic Plains Ecozone

Werger & Coetzee (1978) classified this ecozone as part of the Moderate Plains Bushveld. The area lies west of the Kransberg block and includes the plains to the east and northeast of Thabazimbi within the Waterberg Biosphere Reserve, stretching towards the Kransberg. The ecozone is represented in the plains area of the Marakele National Park, which includes the area at Kwaggasvlakte and the old cattle farms around Duikerspan to the north. The plains within which the ecozone occurs were distinguished by using the geomorphology of the area, the soil types, and the geology, as seen in the catena of the ecozone (Fig. 5.10). This ecozone is a mosaic of different plant communities due to the great variation in geological formations that converge in this area; post-Waterberg intrusions like diabase, dolerite and gabbro are present. The geology varied from granite and granophyre on the most western plains of the Marakele National Park, local intrusions of diabase, gabbro and granophyre in the north (Coetzee *et al.* 1981), and siltstone, mudstone, shale and Waterberg Sandstone closer to the escarpment (Jansen, 1982). Certain areas are also heavily encroached by woody species (Coetzee *et al.* 1981). The most dominant plant communities occurring on the plains in this ecozone are the following (Ch. 4):

- The *Terminalia sericea-Eragrostis pallens* deep sands major plant community
- The *Cynodon dactylon-Dichrostachys cinerea* old fields and disturbed areas major plant community
- The *Dombeya rotundifolia-Panicum maximum* sweet rocky major plant community
- The *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria and encroached areas major plant community
- The *Acacia nigrescens-Grewia flava* plains major plant community

The areas closer to the mountains are Sour Bushveld (Acocks, 1988), and are dominated by deep Clovelly soils, originating from Waterberg sandstone of the Skilpadkop formation, on which the *Terminalia sericea-Eragrostis pallens* community dominates. These areas also provide the suitable habitat for the sandveld-termitaria, *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria. Areas further away from the mountains were previously overgrazed when used for cattle farming, and serious encroaching occurred on these sandy areas, often forming thickets dominated by woody species such as *Dichrostachys cinerea, Acacia erubescens* and *Acacia mellifera* (Coetzee *et al.* 1981). The Kwaggasvlakte plains area of the Marakele National Park is underlain by granite and can be compared to the Mixed Bushwillow Woodlands Ecozone in the Kruger National Park (Jacana, 1997). The plant community represented is the *Acacia nigrescens - Grewia flava* plains community, also described by Schmidt (1992). Low-lying areas are often dominated by *Acacia* species, while slight undulations cause *Combretum* species to become more dominant. However, these areas rather form a mosaic, as described by Winterbach (1998), and no definite distinction between vegetation communities can be made at this scale. The sandy, low-lying areas of this ecozone also include the *Cynodon dactylon-Dichrostachys cinerea* old fields community, mostly of the secondary successional stage.

Towards the northern parts, diabase dyke intrusions are prominent and subsequently the sweet *Dombeya rotundifolia-Panicum maximum* community is more prominent in these areas. A typical landscape in the mosaic plains ecozone is shown in figure 5.11.

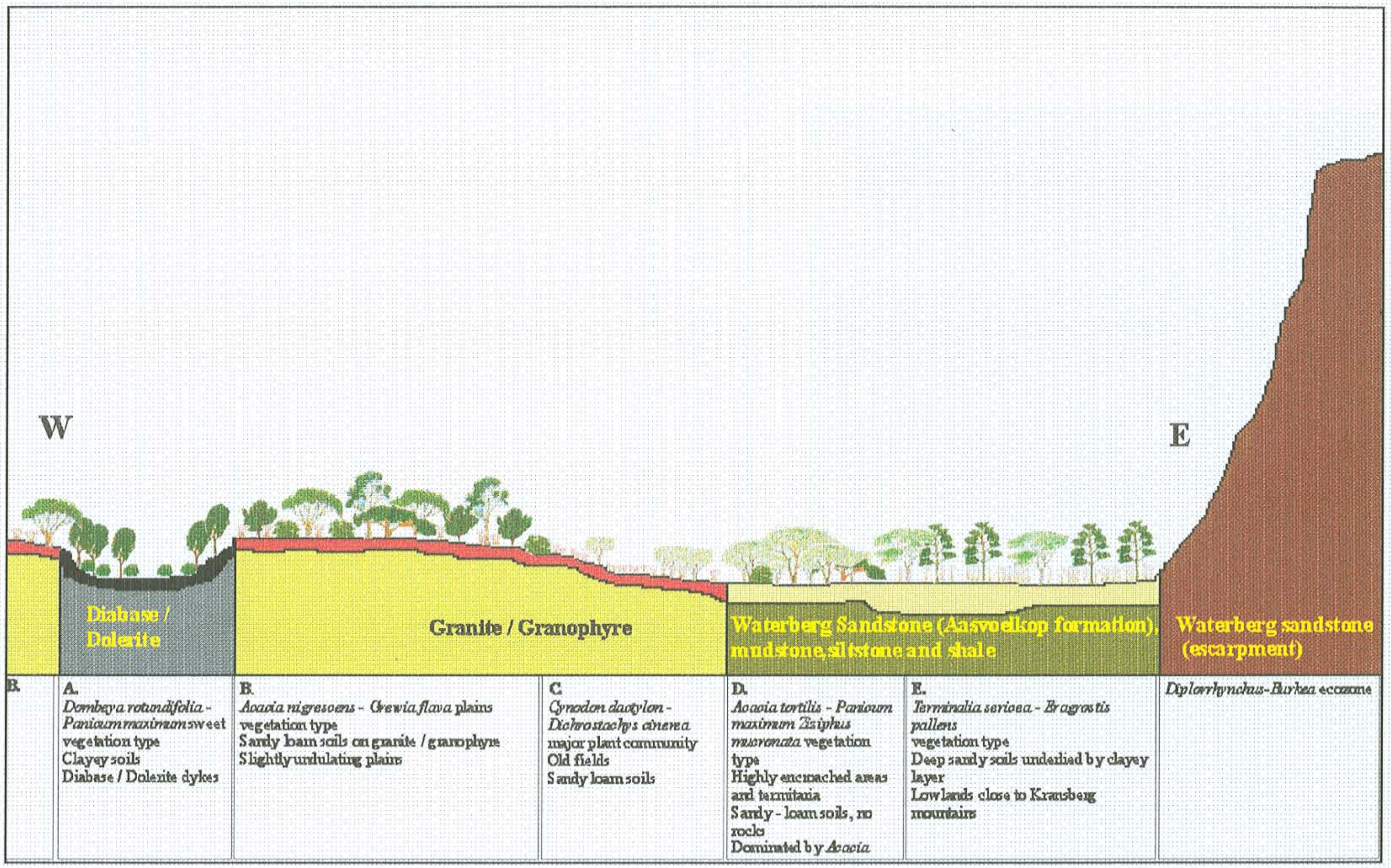


Figure 5.10 Catena of the *Acacia-Combretum-Terminalia* Mosaic Plains Ecozone

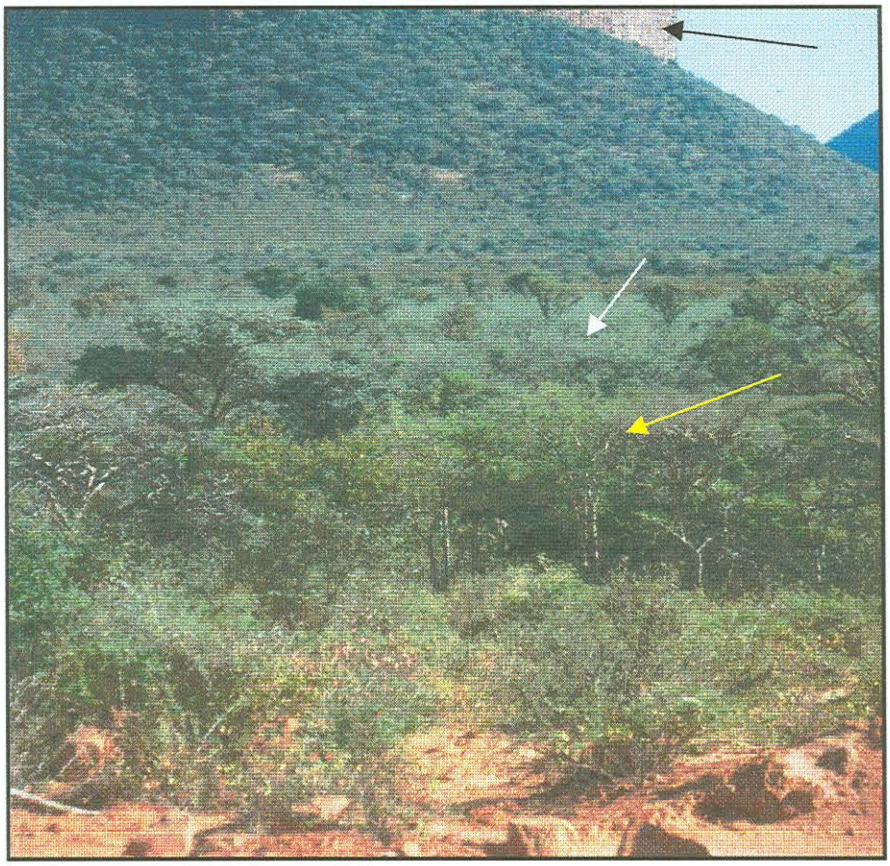


Figure 5.11. The *Acacia-Combretum-Terminalia* mosaic plains ecozone to the west of the Kransberg mountains (black arrow), showing encroached areas (yellow arrow), and a seepage line dominated by *Terminalia sericea* (white arrow)

5.3.2.5 Arid Sweet Low Mountains and Plains Ecozone

This ecozone lies in the northern areas of the Biosphere Reserve. The main environmental parameters used for identification were climate and soil types. The area has a much lower rainfall (average rainfall for Marken 450 mm annually, compared to 620 mm annually at Vaalwater). The ecozone also lies at lower altitudes between 900 and 1000 m. The area has two different geomorphological formations. The far northern parts form extensive mountainous terrain with low-lying valleys and plains, well represented in the Wonderkop Nature Reserve (Fig. 5.13). Soils are mostly shallow rocky Mispah and Glenrosa soil types in the mountainous parts derived from Waterberg Sandstone of the Mogalakwena and Makgabeng formations, while the soils of the plain areas are mostly red-yellow apedal, freely drained soils with a high base status, derived from sedimentary stones (ENPAT, 2000). Plain areas with scattered mountains and hills dominate the southern area of the ecozone. The following major plant communities occur in the ecozone (Ch. 4):

- The *Dombeya rotundifolia-Panicum maximum* sweet rocky major plant community
- The *Acacia nigrescens-Grewia flava* plains major plant community
- The *Burkea africana-Setaria sphacelata* footslopes and terraces major plant community
- The *Terminalia sericea-Eragrostis pallens* deep sands of drainage lines major plant community
- The *Cynodon dactylon-Dichrostachys cinerea* old fields and disturbed areas major plant community

The low mountains occurring to the north form an extremely interesting ecosystem. The underlying geology is Waterberg sandstone, yet due to the drier conditions, common Waterberg species like *Englerophytum magalismontanum* and *Diplorhynchus condylocarpon* do not occur here. The dominant vegetation type of the rocky mountainous terrain represents the *Dombeya rotundifolia-Panicum maximum* sweet rocky community, usually common on diabase and dolerite dykes. It is very similar to the *Kirkia wilmsii-Terminalia prunioides* closed mountain bushveld described by Siebert (2001) in Sekhukuneland. Terraces and footslopes of the mountainous areas are represented by the *Burkea africana-Setaria sphacelata* community, especially dominated by *Combretum apiculatum*. Dolerite and diabase dykes do also occur in this ecozone as intrusions. The valleys between the low mountains, and the plains areas in the southern parts of this ecozone, consist of sandy-loam soils on which the *Acacia nigrescens - Grewia flava* plains community occurs. Seepage lines occur within this plains vegetation type, especially in low lying areas where sand may accumulate, and form the habitat of the dominant *Terminalia sericea-Eragrostis pallens* community. Secondary old fields occur on old cultivated fields, while dense stands of *Dichrostachys cinerea* occur in areas of old cattle farms. Both these variations form part of the *Cynodon dactylon-Dichrostachys cinerea* old fields and disturbed areas major plant community. A catena of the ecozone shows the different environmental factors and plant communities that occur in the ecozone (Fig. 5.12).

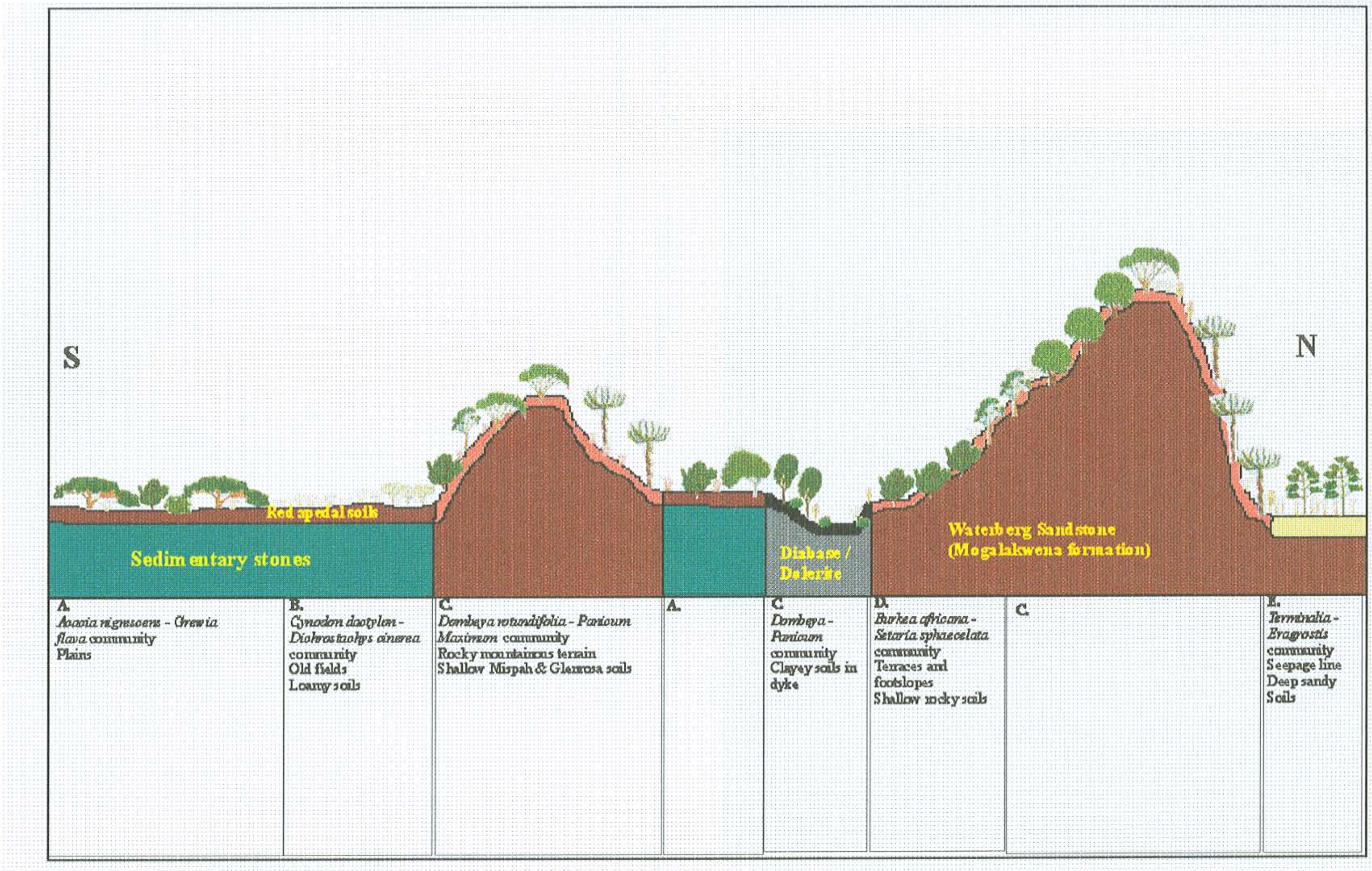


Figure 5.12 Catena of the Arid Sweet Low Mountains and Plains Ecozone

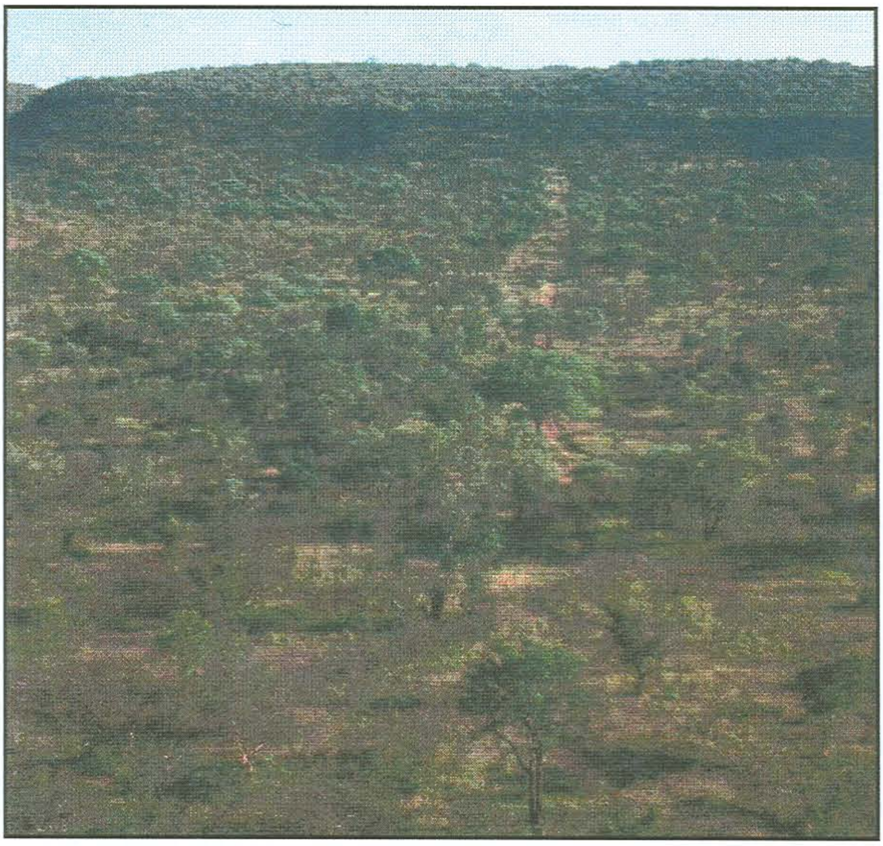


Figure 5.13. A typical landscape of the Arid Sweet Low Mountains and Plains Ecozone in the Wonderkop Nature Reserve, Limpopo Province.

5.3.2.6 Nylsvley Floodplains Ecozone

Coetzee *et al.* (1976) conducted a phytosociological study in this ecozone, which provide some of the most important breeding habitats to waterbirds in Southern Africa. Several soil types and plant communities occur within the Reserve as shown in figure 5.14. The floodplains ecozone was identified as lowlands, having calcareous clayey soils with marsh vegetation, fringed by microphyllous deciduous thorn savannas (Frost, 1987). The soils in these areas are alluvial, illuvial and vertisols (Harmse, 1977). The major plant communities occurring in these low lying clayey areas are the following:

- The *Phragmites australis-Persicaria serrulata* vlei major plant community
- The *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria major plant community
- The *Setaria incrassata-Aristida bipartita* vertic clay major plant community

The permanent wet zone, occuring along the fringes of the Nyl river, representing the *Phragmites australis - Persicaria serrulata* vlei community, have not been described by Coetzee *et al.* (1976), This ecozone plays an important role in providing the habitat for several fish species, waterbird feeding and nesting sites, and drinking place to mammals. The permanent wet zone is surrounded by the *Setaria incrassata-Aristida bipartita* vertic clay community type. The vegetation structure was classified by Coetzee *et al.* (1976) as tree savanna and grassland, closely related to the Black Turf Thornveld (Acocks, 1988) occurring on heavy, calcareous clays. The vegetation consists mainly of a seasonally wet grassland of grasses and forbs. Woody species occur on the drier sites and the crests of gilgai mounds. The absence of woody elements reflects the seasonally high water table of these soils which tend to drown any woody seedlings (Frost, 1987). The *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria vegetation type occurs on the lighter, less compacted and less brackish soils and on often impenetrable termitaria thickets (Coetzee *et al.* 1976). The ecozone is represented in the Nylslvley catena which consist of three different ecozones, coming together in an area of only 2300 hectares (Fig. 5.14). Figure 5.15

shows the seasonally flooded grassland and the vertic clay thornveld in the floodplains area of the Nylsvley Nature Reserve.

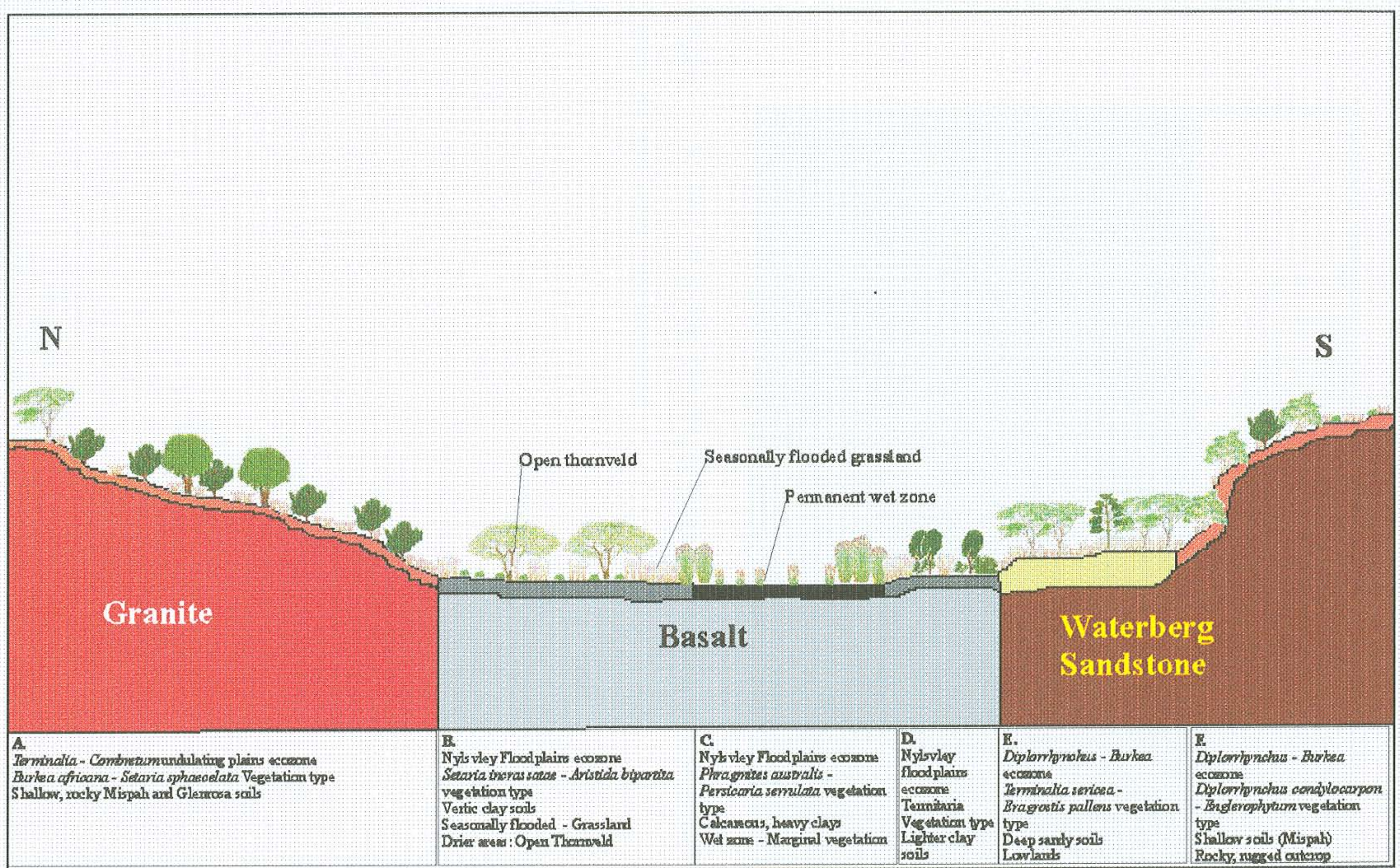


Figure 5.14 Catena of the Nylsvley Nature Reserve, indicating the Nylsvley Floodplains Ecozone

Figure 5.15. The Nylsvley floodplain Ecozone showing the seasonally flooded grassland and vertic clay thornveld

5.4 Conclusion

Booth *et al.* (1994) classified South Africa into 10 different ecozones, mostly based on the vegetation biomes identified by Rutherford & Westfall (1986). Jacana (1997) produced a tourism booklet on the ecozones of the Kruger National Park based on the combination of similar landscapes described by Gertenbach (1983). This showed that ecozones could be identified as smaller units within a large area, comparing differences in environmental parameters like climate, geology, soils and geomorphology.

The following ecozones were identified within the Waterberg Biosphere Reserve based on geology and soils, climate, altitude and geomorphology:

- *Protea-Englerophyton* High Altitude Escarpment Ecozone
- *Diplorhynchus-Burkea* Rolling Mountain Ecozone
- *Terminalia-Combretum* Undulating Plains Ecozone
- *Acacia-Combretum-Terminalia* Mosaic Plains Ecozone
- Arid Sweet Low Mountains and Plains Ecozone
- Nylsvley Floodplains Ecozone

Scientists who study ecozones do not agree on exactly where they are, or even how to define them, due to attaching different importance values to combination of environmental factors (Booth *et al.* 1994). The ecozones identified within the Waterberg Biosphere Reserve were also done placing importance on different environmental factors. For example, the *Protea-Englerophytum* High Altitude Ecozone was identified as areas above 1500 m altitude, while the *Diplorhynchus - Burkea* rolling mountain ecozone was identified occurring on specific geological formations (below 1500 m) which create a specific geomorphological landscape. The importance for the identification of these ecozones is that they must be easily recognizable and the criteria is that at least 2 of the environmental parameters must be identified as different from other areas.

Jacana (1997) provides tourists with useful information on the habitats of the larger mammals within the Kruger National Park. The ecozones within the Waterberg Biosphere Reserve will provide the same basis to show mammal, bird and tree habitat within plant communities to tourists, as discussed in the following chapter.

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CHAPTER 6
THE TREES AND SHRUBS OF THE WATERBERG BIOSPHERE RESERVE AND THEIR VALUE TO THE TOURISM INDUSTRY

6.1 Introduction

The presence of trees in the landscape and their characteristic growth forms often reflect the biome, veld type or habitat to which the tree is adapted. Different structural variations occur within the upper layer of woody plants of the Savanna Biome of Southern Africa, namely Shrubveld (short, close to the ground), Woodland (tall, dense woody component) and Bushveld (intermediate stage) (Low & Rebelo, 1996). Several of the 1700 indigenous tree and shrub species within southern Africa (Van Wyk & Van Wyk, 1997) are restricted to this biome, and the shrub-tree layer may vary from 1 to 20 m in height, although typically being between 3 and 7 m in the Bushveld (Low & Rebelo, 1996).

Trees have been an essential part of human existence and survival since the earliest time. They provide shelter, food and clothing, timbre, fiber, firewood, medicine, poison, tans and dyes (Van Wyk *et al.* 2000). Several botanists have studied and recognized the practical values of trees and shrubs for the many African cultures (Van Wyk *et al.* 1997; Van Wyk & Gericke, 2000). Furthermore, trees are important in maintaining a healthy savanna ecosystem, and a host of organisms depend entirely on trees for their survival. However, it is still the imposing architecture, enormous size and spectacular flowering displays of trees that inspire people (tourists) (Van Wyk *et al.* 2000).

Corporate Author (1991) showed how valuable the mangrove trees of the Kisarawe District, Tanzania can be for the tourism industry. Considering the diversity and many interesting characteristics and conspicuousness of trees and shrubs within southern Africa, the value of these plants for tourism might be huge if tourists are made conscious of them. However, the conservation and management of the many indigenous trees of the Savanna Biome should never be neglected for tourism purposes.

The aim of this chapter is to show the value of trees and shrubs within the different identified plant communities (Chapter 4) of the Waterberg Biosphere Reserve to the tourism industry. Values will be allocated to each woody species in terms of synoptic table frequency values and tourism values (medicinal properties, browsing value, conspicuousness, general uses and diagnostic species).

6.2 Methods

6.2.1 Synoptic table reduction

The trees and shrubs species in the synoptic table (Table 4.2, Chapter 4) of the plant communities of the Waterberg Biosphere Reserve were identified. The grasses, forbs, wild flowers and herbaceous species were removed from the synoptic table to produce a new reduced synoptic table with 33 species groups for the trees and shrubs presented in Table 6.1. Trees were absent from the *Fuirena pubescens-Andropogon huilensis* sponges and *Phragmites australis-Persicaria serrulata* vlei communities, and were subsequently discarded from the table. The following steps were followed after reduction of the original synoptic table was done:

- All the frequency values of trees and shrubs lower than 10% were discarded
- The frequency values of 10% and above were divided by 20 to give a frequency value out of 5. These values were used in the following analysis.

6.2.2 Tree characteristics

Trees have many functions and are essential to our existence (Venter & Venter, 1996). Although the frequency values in the synoptic table (Table 6.1) give information on the distribution / abundance of trees and shrubs in the associated plant communities, tourists would like to know interesting facts about trees and shrubs (e. g. medicinal properties, food source value to mammals, human uses), especially when in flower. Therefore every tree and shrub species was evaluated and given marks in terms of the interesting characteristics as presented in Table 6.2. These characteristics were obtained from information in field guides (Venter & Venter, 1996; Van Wyk &

Van Wyk, 1997; Van Wyk *et al.* 2000). The values of the trees and shrubs for each characteristic are presented in Appendix 6.1.

Table 6.2 Tree and shrub characteristics valuable to tourism

Tree / Shrub Characteristics	Mark
Medicinal / Veterinary Properties	Yes - 1; No - 0
Food source to mammals or birds	Yes - 1; No - 0
Wood / Leaf / Bark use by humans	Yes - 1; No - 0
Conspicuousness	2 marks in terms of conspicuousness: growth form - 1, Flowers - 1; None of above - 0
Diagnostic to a community / habitat (Table 4.2, Chapter 4)	Yes - 1; No - 0

The total values of trees or shrubs out of 6 were then converted to a value out of 5.

6.2.3 Tree tourism values

The values for the trees (out of 5) for frequency / abundance in plant communities and the tourism value of trees (out of 5) (Appendix 6.1) were combined to give a value out of 10. This value was converted to a percentage value. Trees and shrubs within each community thus get a value within each community based on their abundance / frequency and special characteristics possibly valuable for tourists. The trees were subsequently rated within each community for their importance to tourism, although their abundance in specific communities cannot be neglected.

6.3 Results and Discussion

A total of 117 trees and shrubs within the Waterberg Biosphere are included in Table 6.2, and although more species may occur in the Biosphere Reserve, the species included were selected from the synoptic table in Chapter 4. The following section gives a short description of the most dominant trees and shrubs in the plant communities (Chapter 4) and their value to tourism in the Waterberg Biosphere Reserve.

6.3.1 *Podocarpus latifolius-Diospyros whyteana* Kloof Community

This community represents part of the Afro-Montane element of southern Africa (Coetzee *et al.* 1981). Large trees like *Podocarpus latifolius* and *Celtis africana* occur within kloofs, which are often dominated by trees, shrubs and climbers (Acocks, 1988). Woody plants represent 50 % of the species within forests, and include canopy trees (15 %), subcanopy trees (27 %), woody shrubs (47 %) and woody climbers (11 %). The physical characteristics of the kloofs within the Waterberg Biosphere Reserve include deep ravines and gorges under similar moist conditions to the kloof communities of the eastern Orange Free State Drakensberg (Du Preez *et al.* 1991). The size and species composition of different forest patches may vary (Geldenhuys, 1999). The trees and shrubs within the community according to their combined (tourism and abundance) values (rating) are as follows:

Podocarpus latifolius	68.7	*Dovyalis zeyheri*	40.3
Syzygium cordatum	63	*Vangueria infausta*	40.3
Diospyros whyteana	62.3	*Grewia occidentalis*	39.3
Celtis africana	61.7	*Pterocelastrus echinatus*	39.3
Rothmannia capensis	59.5	*Euclea natalensis*	39.3
Ficus sur	54.7	*Berchemia zeyheri*	39.3
Curtisia dentata	52.2	*Cussonia paniculata*	39.3
Calpurnia aurea	52.2	*Combretum molle*	39.3
Ilex mitis	52.2	*Rhus leptodictya*	39.3
Kirkia wilmsii	51.2	*Myrsine africana*	38.7
Acacia caffra	49.7	*Osyris lanceolata*	38
Syzygium guineense	48.7	*Clutia pulchella*	34.5
Dombeya rotundifolia	48.7	*Canthium gilfillanii*	34.5
Brachylaena rotundata	48.7	*Heteropyxis natalensis*	34.5
Olea europaea	48.3	*Mimusops zeyheri*	34.5
Cussonia spicata	47.7	*Maytenus undata*	33.2
Apodytes dimidiata	47.7	*Widdringtonia nodiflora*	33
Acokanthera oppositifolia	44.8	*Rhus dentata*	33
Buxus macowanii	44.8	*Olea capensis*	32
Ficus thonningii	43.8	*Englerophytum magalismontanum*	32
Croton gratissimus	42.8	*Ochna holstii*	31
Pappea capensis	42.8	*Diospyros lycioides*	31
Pittosporum viridiflorum	41.3	*Euphorbia ingens*	29.7
Faurea saligna	41.3	*Tricalysia lanceolata*	19.8
Vepris lanceolata	40.3		

Trees with higher values (e. g. *Podocarpus latifolius, Diospyros whyteana, Celtis africana*) may be seen as general trees in kloof communities with high significance to tourism, while trees like *Widdringtonia nodiflora* are more rare. Tourists interested in trees might find the kloof communities extremely fascinating on walking trials, although care must be taken since these areas are usually wet and slippery, and small trees and shrubs (e. g. *Diospyros whyteana*) often form dense thickets at the entrance of ravines. The kloof communities also provide shelter and food to dangerous mammal species like leopard and elephant (Skinner & Smithers, 1990), and in nature reserves, guided walks should rather be undertaken into kloof communities. The potential danger of the trampling of sensitive species (e. g. fern species, mosses) in the herbaceous stratum of kloof forests must also be taken into consideration when planning walking trial paths in kloof forest, and special management principles need to be applied to prevent damage. For example the trial should rather follow paths used by animals and should be as narrow as possible.

The community provides tourists the opportunity to identify and see some of the many large trees associated with this moist, sheltered habitat. Geldenhuys (1999) noted that southern African forests also play an increasingly important role in providing recreation and aesthetics for the growing urbanized and industrialized societies. The recognition of the products and values of forests is one of the basic requirements in order to reduce conflicts in land-use options and to conserve forests. The availability of recreation areas, like the Waterberg Biosphere Reserve, is important not only for the burgeoning tourist industry, but also as a tool in conservation education (Geldenhuys, 1999).

6.3.2 *Protea caffra-Loudetia simplex* Cool Slopes Community

This community may vary greatly as shown in Chapter 4. Not many tree species occur, and shrub species like *Englerophytum magalismontanum* are more common. The structure of the community is mostly an open woodland (Edwards, 1983) and small trees like *Protea caffra* often dominate rocky southern slopes. The following important trees and shrubs occur in this community according to their value rating:

Protea caffra	63.7
Vangueria infausta	57.8
Protea roupelliae	52.7
Acacia caffra	46.7
Englerophytum magalismontanum	43.0
Vitex rehmannii	41.3
Rhus dentata	41.0
Faurea saligna	39.8
Combretum molle	39.3
Ozoroa paniculosa	38.3

Heteropyxis natalensis	30.5
Maytenus tenuispina	14.8
Ancylobotrys capensis	13.3

Acocks (1988) describes the higher parts of mountains in Northeastern Mountain Sourveld as scrubby thornveld, sometimes forming dense thickets where, apparently the breaking down of forest into grassveld has never been completed. The high altitude areas within this community are classified as the sourveld variation of Northeastern Mountain Sourveld by Acocks (1988). Van Staden (in prep.) described these areas in the Marakele National Park, although they occur on most southern slopes and eastern slopes throughout the Biosphere Reserve. The plant species composition and species richness of this community suggest that the vegetation have a heterogeneous origin, with contributions from grassland, savanna and the Drakensberg. (Bredenkamp, 1999).

Trees occur sparsely in this community, although when in flower, both *Protea* species are extremely conspicuous (Van Wyk *et al.* 2000), while fruitbearing species like *Englerophytum magalismontanum* and *Ancylobotrys capensis* provide tourists the opportunity to taste these edible wild fruits (Van Wyk & Gericke, 2000). The presence of these edible fruits, together with poisonous and medicinal plants could provide useful environmental education to hikers (Wahl & Hugo, 1995) or tourists visiting the area. Other savanna species like *Acacia caffra* and *Combretum molle* occur in slightly warmer, sheltered spots, while Coetzee *et al.* (1981) noted that species like *Heteropyxis natalensis* and *Faurea saligna* are only dominant in the coolest deciduous bushveld communities. The low tree diversity provides tourists with an opportunity to easily identify most of the trees and shrubs in the community, while the low density of trees and shrubs also allow walking trials to be designed through it. However, Wahl & Hugo (1995) noted that erosion could occur on walking trial paths if the gradient exceeds 6 to 8 degrees, and this must be taken into consideration. However, the high altitude areas (1500-2100m above sea level) of the community (e. g. Marakele National Park) have spectacular visual beauty over the surrounding areas, and this is even further enhanced when the *Protea* species occurring in this community are flowering.

6.3.3 *Diplorhynchus condylocarpon-Englerophytum magalismontanum* Rocky Slopes community

Typically sourveld of the warm slopes of lower altitude (< 1500 m) mountainous regions, this community includes several deciduous, broadleaf species (Coetzee *et al.* 1981). The trees of the savanna biome are well adapted to browsing and possess several survival strategies (Bredenkamp, 1999[b]). The diversity of trees and shrubs are high within this community and the following species occur in the community, with the values representing their importance value:

Combretum molle	76.8	*Dombeya rotundifolia*	47.7
Burkea africana	67.8	*Brachylaena rotundata*	47.2
Lannea discolor	67.2	*Combretum zeyheri*	45.8
Elephantorrhiza burkei	61.7	*Croton gratissimus*	45.3
Diplorhynchus condylocarpon	61.3	*Tapiphyllum parvifolium*	43.5
Englerophytum magalismontanum	58.0	*Combretum apiculatum*	42.8
Mundulea sericea	54.7	*Euclea natalensis*	41.3
Pterocarpus rotundifolius	54.2	*Faurea saligna*	39.8
Vitex rehmannii	53.8	*Ziziphus mucronata*	38.3
Ozoroa paniculosa	53.3	*Rhus leptodictya*	37.8
Vangueria infausta	52.8	*Rhoicissus revoilii*	35.2
Ochna pulchra	51.3	*Heteropyxis natalensis*	32.5
Pseudolachnostylis maprouneifolia	51.3	*Rhus dentata*	30.5
Terminalia sericea	49.7	*Grewia monticola*	30.5
Gardenia volkensii	49.2	*Maytenus tenuispina*	28.3
Vitex pooara	48.7	*Hexalobus monopetalus*	25.7
Strychnos pungens	48	*Strychnos madagascariensis*	24.2
Combretum nelsonii	47.7	*Ancylobotrys capensis*	13.8

Two Waterberg endemics occur within this community namely *Vitex pooara* and *Combretum nelsonii* (Van Wyk & Van Wyk, 1997). Fruit-bearing species like *Strychnos* species, *Englerophytum magalismontanum*, *Vangueria infausta* and *Ancylobotrys capensis* are present, and are utilized by the local communities and animal species (Van Wyk & Gericke, 2000). Certain tree and shrub species might be more common when the environmental conditions are more suitable. Species like *Diplorhynchus condylocarpon* dominates over large areas of warm, low-lying mountainous terrain of the Waterberg. However, dominant species within this community are only indicators of combinations, which include several woody species (Coetzee *et al.* 1981).

Tourists visiting the Waterberg Biosphere Reserve will encounter most of the woody species during game drives or walks. The woody species often also have medicinal properties (Appendix 6.1), and species like *Dombeya rotundifolia, Ochna pulchra* and *Gardenia volkensii* are quite conspicuous when flowering (Van Wyk & Van Wyk, 1997). Guides may thus share many interesting facts about these trees with tourists during activities. Tourists interested in botany will find this community challenging to identify the many trees and shrubs occurring on the many varying warm slopes of the Waterberg Biosphere Reserve.

6.3.4 The *Burkea africana-Setaria sphacelata* Undulating Plains, Terraces and Footslopes Community

This community can be found in many different areas of the Waterberg Biosphere Reserve. It plays a major role as one of the dominant communities in the Mixed Bushveld Vegetation Type described by Van Rooyen & Bredenkamp (1996). The tree and shrub diversity is relatively high, and similar woody species occur compared to the *Diplorhynchus condylocarpon-Englerophytum magalismontanum* community. However, similar species have different importance values between the two communities, and the trees and shrubs accordingly are the following:

Protea caffra	60.2	*Ochna pulchra*	42.3
Elephantorrhiza burkei	59.7	*Terminalia sericea*	41.7
Vitex rehmannii	56.3	*Combretum zeyheri*	39.3
Acacia caffra	54.7	*Ximenia caffra*	38.8
Vangueria infausta	54.3	*Ziziphus mucronata*	38.3
Faurea saligna	54.3	*Combretum apiculatum*	37.8
Lannea discolor	54.2	*Heteropyxis natalensis*	36.0
Dombeya rotundifolia	52.2	*Mimusops zeyheri*	34.5
Burkea africana	51.8	*Rhus dentata*	34.0
Apodytes dimidiata	51.2	*Olea capensis*	32.5
Brachylaena rotundata	49.2	*Tapiphyllum parvifolium*	31.5
Combretum nelsonii	47.7	*Diospyros lycioides*	31.0
Ozoroa paniculosa	47.3	*Strychnos pungens*	30.0
Gardenia volkensii	47.2	*Rhoicissus revoilii*	27.2
Pterocarpus rotundifolius	46.2	*Gymnosporia buxifolia*	23.7
Euclea crispa	44.3	*Ancylobotrys capensis*	17.3
Rhus leptodictya	42.8	*Maytenus tenuispina*	14.8

This structure of this community is an open woodland (Edwards, 1983), and different tree species might dominate the varying foothills, undulating plains, terraces and plateaus. Acocks (1988) classified variations within the Mixed Bushveld Veld Type mostly according to the occurrence of the woody species. On the shallow, rocky soils of the undulating plains and terraces, *Combretum apiculatum* is the dominant tree (Bredenkamp, 1999[b]), while other typical species include *Pterocarpus rotundifolius*, *Combretum nelsonii*, *Englerophytum magalismontanum* and *Combretum molle*. Two variations of the Mixed Bushveld Veld Type classified by Acocks (1988) are similar to the above mentioned areas, namely *Combretum apiculatum* Veld Proper, and *Combretum-Pterocarpus* Veld. On the slightly deeper sandy soils with interspersed rocks of the plateaus and foothills, almost pure stands of *Burkea africana* occur (Coetzee *et al.* 1981), with species like *Combretum zeyheri*, *Ochna pulchra, Maytenus tenuispina*, *Elephantorrhiza burkei* and *Dombeya rotundifolia.* Acocks (1988) classified this as the *Burkea* veld variation within the Mixed Bushveld Veld Type. Fruit-bearing species are similar to the *Diplorhynchus* community, and most of the trees have some medicinal properties. However, these plants play an important role in providing food to browsers like kudu on the many game reserves and game farms in the Waterberg Biosphere Reserve, and certain animals seem to prefer grazing in these rocky areas (Eltringham, 1979) (Chapter 7).

Tourists may find the identification of trees and shrubs within this community slightly easier compared to previously discussed communities. The woody species composition of localized communities doesn't seem to vary much, and is sometimes low due to the dominance of species like *Combretum apiculatum*. However, many interesting tree and shrub species occur, and the tree density makes tourist activities like game viewing and walking trials easy.

6.3.5 The *Terminalia sericea-Eragrostis pallens* Deep Sands Community

This community occurs in the low-lying areas and seepage lines throughout the Biosphere Reserve. Acocks (1988) described it as *Terminalia* Veld Proper due to the fact the tree species *Terminalia sericea* often dominates the infertile, deep sandy soils of these areas (Bredenkamp, 1999[b]). Other trees and shrubs occurring within this community are the following:

Terminalia sericea	79.7	*Ozoroa paniculosa*	49.3
Burkea africana	73.3	*Strychnos pungens*	49.0
Ochna pulchra	68.3	*Vitex pooara*	48.2

Strychnos cocculoides	67.0	*Mundulea sericea*	48.2
Dombeya rotundifolia	61.2	*Securidaca longepedunculata*	47.8
Combretum molle	60.8	*Combretum apiculatum*	42.8
Lannea discolor	59.7	*Ximenia caffra*	40.3
Vitex rehmannii	58.8	*Euclea undulata*	39.8
Dichrostachys cinerea	57.3	*Rhus leptodictya*	39.8
Combretum zeyheri	55.3	*Diplorhynchus condylocarpon*	37.8
Grewia flavescens	52.5	*Diospyros lycioides*	31.0
Peltophorum africanum	51.7	*Grewia monticola*	29.5
Euclea natalensis	50.3		

Typical woody species that are associated with sandy soils of low-lying areas are *Terminalia sericea, Burkea africana, Ochna pulchra* and *Securidaca longepedunculata*. Although dense, fairly tall bush occurs on deep loose sand of seepage lines (Acocks, 1988), the vegetation structure of the community is generally an open woodland (Edwards, 1983). The community is often dominated by a few tree species, with a scanty undergrowth of small shrubs like *Diospyros lycioides*, *Grewia flasvescens, Vitex rehmanii* and *Euclea undulata*, varying in species composition from place to place (Acocks, 1988).

The diversity of woody species is low in this community, possibly due to the homogenous substrate and low nutrients in the soil. This, together with the low density of woody species result in the easier identification of tree species in the community, although the community does not provide as much opportunity to tourists interested in botany. Trees like *Peltophorum africanum* and *Ochna pulchra* are however quite conspicuous when in flower and seem to attract tourists' attention when in flower. The ever-present *Terminalia sericea* does not only attract attention with its silvery clustered leaves and reddish seeds, mammals also browse the species at certain times of the year, as several other species in this community. Although certain interesting tree species occur within this community, the community is not the best in terms of diversity, however, tourists might find the identification of most of the trees easier than other communities.

6.3.6 The *Cynodon dactylon-Dichrostachys cinerea* Old Fields Community

Woody species occurring in this community only occurs as part of the older successional stage of old fields or disturbed overgrazed areas (Chapter 4). The secondary old fields are often only dominated by one or two tree species at the stage where woody species start to invade the old fields. Bothma (2000) noted that incorrect grazing practices, often occurring on old fields, reduce the growth and water utilization of grasses close to the soil surface, causing increased competition from woody species. More species are however associated with disturbed areas, like the abandoned settlements within the Nylsvley Nature Reserve described by Coetzee *et al.* (1976). Within the community the following woody species occur within disturbed areas and secondary old fields (numerical values indicate importance):

Terminalia sericea	69.2	*Ziziphus mucronata*	43.8
Peltophorum africanum	53.2	*Combretum zeyheri*	43.3
Burkea africana	50.8	*Ochna pulchra*	41.8
Dichrostachys cinerea	50.8	*Grewia flava*	40.8
Pterocarpus rotundifolius	50.2	*Grewia bicolor*	40.3
Terminalia brachystemma	49.7	*Ozoroa paniculosa*	39.3
Acacia caffra	49.7	*Rhus pyroides*	39.3
Acacia karroo	49.7	*Faurea saligna*	38.3
Lannea discolor	49.2	*Rhus leptodictya*	37.8
Dombeya rotundifolia	48.2	*Euclea natalensis*	37.3
Combretum apiculatum	46.8	*Grewia flavescens*	37.0
Euclea crispa	44.8	*Grewia monticola*	30.0
Vitex rehmannii	44.3	*Rhoicissus revoilii*	20.2
Combretum molle	43.8		

The geology and soils on which the old fields occur will mostly determine the woody species composition of secondary old fields. Old fields associated with sandy soils will favour the growth of species like *Terminalia* species, *Burkea africana* and *Lannea discolor*, while more loamy or clayey soils will provide suitable invading habitat to species like *Dichrostachys cinerea, Acacia karroo* and *Ziziphus mucronata*. These areas usually attract large numbers of game (Chapter 7), and therefore the trees growing in this community can be identified by the tourists while doing a game drive. Browser-grazers (e. g. impala) usually utilize trees like *Dichrostachys cinerea* in this community. Conspicuous trees include *Dichrostachys cinerea, Acacia karroo* and *Dombeya rotundifolia* (flowers), *Burkea africana, Faurea saligna* and *Terminalia sericea* (growth form).

This community does have more woody species compared to the *Terminalia sericea-Eragrostis pallens* community, however, the tree diversity and density are usually low in the old fields, and the species composition rather depend on the age of old fields, similar to those in the Transkei (Smits *et al.* 1999). Tourists visiting nature reserves might not be interested in identifying or learning about the trees within these areas, since the areas are usually overpopulated by game. However, the disturbed areas (old villages, kraals etc.) provide an excellent opportunity for cultural tourism, since about 30% of all foreign visitors have some sort of a cultural experience during their stay in South Africa (DEAT, 1998).

6.3.7 The *Dombeya rotundifolia-Panicum maximum* Sweet Rocky Community

The woody component of this community is usually dense along diabase and dolerite dykes, as well as on the outcrops of these stones. Canopies of woody plants sometimes touch and interlock, contributing 30-40% cover. Trees and shrubs do not exceed 5m in height (Van der Meulen, 1979). The following trees and shrubs occur within this community according to importance values:

Dombeya rotundifolia	77.2	*Vitex rehmannii*	45.8
Ziziphus mucronata	73.3	*Pseudolachnostylis maprouneifolia*	44.8
Pappea capensis	67.3	*Cussonia paniculata*	43.8
Schotia brachypetala	63.5	*Croton gratissimus*	43.8
Euclea crispa	61.8	*Grewia flavescens*	43.0
Rhus leptodictya	60.8	*Combretum hereroense*	42.3
Kirkia acuminata	60.5	*Diospyros whyteana*	41.3
Clerodendrum glabrum	60.5	*Vangueria infausta*	41.3
Acacia caffra	59.7	*Grewia bicolor*	41.3
Combretum apiculatum	57.3	*Mimusops zeyheri*	41.0
Aloe marlothii	55.5	*Obetia tenax*	40.3
Acacia karroo	55.2	*Diplorhynchus condylocarpon*	40.3
Brachylaena rotundata	53.2	*Combretum zeyheri*	40.3
Peltophorum africanum	53.2	*Ficus thonningii*	40.3
Grewia flava	52.8	*Boscia albitrunca*	40.3
Ximenia americana	52.2	*Grewia monticola*	40.0
Sclerocarya birrea	52.2	*Ozoroa paniculosa*	38.8
Euclea natalensis	51.3	*Faurea saligna*	38.8
Lannea discolor	50.7	*Euclea undulata*	37.8
Elephantorrhiza burkei	50.7	*Gymnosporia buxifolia*	36.2
Gardenia volkensii	50.7	*Englerophytum magalismontanum*	35.5
Berchemia zeyheri	50.3	*Heteropyxis natalensis*	32.0
Dichrostachys cinerea	49.3	*Commiphora mollis*	32.0
Spirostachys africana	48.7	*Diospyros lycioides*	30.5
Pterocarpus rotundifolius	48.7	*Euphorbia ingens*	30.2
Olea europaea	48.3	*Euphorbia cooperi*	29.5
Acacia nigrescens	48.3	*Rhoicissus revoilii*	23.7
Terminalia sericea	47.2	*Strychnos madagascariensis*	23.7
Combretum molle	46.8	*Maytenus undata*	23.7
Bridelia mollis	45.8	*Acacia robusta*	23.7

Several tree species are quite conspicuous within this community. The community is also the most diverse community in terms of woody species composition compared to other communities in the Biosphere Reserve. Species like *Dombeya rotundifolia* and *Schotia brachypetala* are conspicuous when in flower, and dense stands of these trees are very striking when flowering. *Euclea undulata* is often the dominant shrub, while trees like *Acacia karroo, Pappea capensis, Rhus pyroides, Ziziphus mucronata* and *Spirostachys africana* are locally dominant in the tree layers on diabase dykes (Van der Meulen, 1979). The tree diversity is further increased due to the fact that a mixture of sweet bushveld associated woody species (e. g. *Sclerocarya birrea, Acacia nigrescens*) and sourveld associated species (e. g. *Diplorhynchus condylocarpon, Englerophytum magalismontanum*) occur together on the diabase rocky outcrops. Many tree species are also of importance to local communities. Fruit-bearing species like *Berchemia zeyheri* and *Pseudolachnostylis maprouneifolia* are present, while tree species like *Combretum apiculatum* and *Dichrostachys cinerea* are important sources of indigenous firewood (Van Wyk & Gericke, 2000). The leaves and twigs of several of the tree species like *Combretum* species, *Acacia* species and *Grewia* species, further provide nutritious meals to browsing animals (Van Wyk *et al.* 2000), and this might interest tourists to show interest about the specific tree species being browsed on.

This community has a high potential for tourists interested in identifying the many interesting tree species in the Biosphere Reserve. The tree diversity and density over a small area, will certainly challenge tourists to identify as many trees as possible, however the tree density might also be too dense for tourist to move around freely.

6.3.8 The *Acacia tortilis-Panicum maximum-Ziziphus mucronata* Termitaria and Encroached Areas Community

This community does not have the highest tree diversity but localized communities are rather dominated by individual woody species (Chapter 4). Coetzee *et al.* (1981) observed that large areas of the plains within the Mosaic Ecozone (Chapter 5) are encroached by *Dichrostachys cinerea*, which excludes several other woody species. Both the vegetation of these areas, and termitaria comprise dense, often impenetrable, thorny bushclumps (Van der Meulen, 1979). The trees and shrubs include the following species:

Dichrostachys cinerea	66.3	*Acacia mellifera*	43.8
Acacia karroo	61.7	*Combretum hereroense*	43.3
Ehretia rigida	58.2	*Combretum apiculatum*	42.3
Acacia erioloba	57.5	*Rhus pyroides*	41.8
Acacia burkei	57.5	*Acacia nigrescens*	41.3
Ziziphus mucronata	53.8	*Pappea capensis*	40.8
Grewia flava	51.3	*Euclea divinorum*	40.8
Terminalia sericea	50.7	*Euclea crispa*	39.8
Grewia bicolor	50.3	*Combretum imberbe*	39.3
Peltophorum africanum	49.2	*Grewia monticola*	34.0
Acacia erubescens	47.8	*Gymnosporia polyacantha*	30.5
Euclea undulata	47.8	*Diospyros lycioides*	30.5
Grewia flavescens	46.5	*Gymnosporia buxifolia*	25.7
Rhus leptodictya	43.8		

The woody species (e. g. *Dichrostachys cinerea* and several *Acacia* species) within the encroached areas provide local communities with firewood. Ellery *et al.* (2000) noted that woody species within encroached areas of the Thukela Biosphere Reserve, Kwazulu-Natal, play an important role in the sustainable utilization of these woody species as firewood, and the same utilization strategy should possibly be followed in the Waterberg Biosphere Reserve. The management and clearance of these areas are extremely important (Bothma, 2000), and the clearance of bush in the Marakele National Park for game-viewing purposes is already being effective (Engelbrecht, pers. comm.). These areas are otherwise often impenetrable and do not favour tree identification on walking trials for tourists interested in botany.

Woody species dominate vegetation associated with termitaria (Van der Meulen, 1979). Emerging trees like *Pappea capensis* are often found in the centre of the bushclump (reaching 8-10m) with other trees (e. g. *Rhus pyroides*, *Ziziphus mucronata*) and shrubs (e. g. *Grewia* species, *Diospyros lycioides*) grouped around them, covering 5-15%. Although the termitaria bushclumps also form dense thickets, tourists might find the identification of the trees easier than the encroached areas, due to the more open surrounding areas (Coetzee *et al.* 1976) and low density of tree species growing on the termitaria. The bushclumps further appear as a striking composition of woody species, and this feature might interest tourists.

6.3.9 The *Acacia nigrescens-Grewia flava* Plains Community

This community is typical of plains areas around the main Waterberg basin. Schmidt (1992) described two structural variations of the woody component of a similar community at Rhino Ranch near Ellisras as short closed woodland (Edwards, 1983), dominated by *Combretum apiculatum*, and tall open woodland (Edwards, 1983), with a tall and short variant, dominated by the woody species *Acacia nigrescens* and *Acacia tortilis* respectively. The diversity of woody species within this community is not high, due to many variations of this community often being locally dominated by certain species. The following woody species occur within the community (numerical values indicates importance):

Acacia tortilis	79.2	*Peltophorum africanum*	51.2
Grewia bicolor	71.8	*Sclerocarya birrea*	50.2
Grewia flava	70.8	*Acacia mellifera*	43.8
Acacia nigrescens	67.8	*Euclea divinorum*	43.8
Dichrostachys cinerea	66.8	*Boscia albitrunca*	41.8
Acacia karroo	54.2	*Combretum imberbe*	39.8
Grewia monticola	54.0	*Commiphora mollis*	35.5
Combretum apiculatum	52.3	*Ehretia amoena*	34.5
Commiphora africana	52.2	*Acacia robusta*	24.2
Boscia foetida	51.7		

Coetzee (1971) noted that woody species from Acocks' (1988) Mixed Bushveld Veld Type (e. g. *Combretum apiculatum, Grewia* species) and Arid Sweet Bushveld Veld Type (*Acacia tortilis, Acacia nigrescens, Boscia* species, *Commiphora* species) form a relationship within this community. Most of the woody species are also eagerly browsed by mammal species (Venter & Venter, 1996), and therefore the woody species further plays an important part for game viewing on game farms and nature reserves. Van der Meulen (1979) classified a similar community as part of the arid habitat of the Xeric lowland bushveld.

Tourists interested in identifying trees or learning about them, might find this community fascinating. The several *Acacia* species are always conspicuous when in flower (Van Wyk *et al.* 2000), while traditional uses of species like *Boscia albitrunca* (Van Wyk & Gericke, 2000) further enhances the potential the woody component of this community has for the tourism industry. The diversity of trees and density of woody species allow tourist activities like walking trials to be provided by ecotourism destinations.

6.3.10 The *Setaria incrassata-aristida bipartita* Vertic Clay Community

This community occurs only within the Nylsvley Nature Reserve and very few woody species occur within it. Coetzee *et al.* (1976) noted that the woody component only occurs where the water table is generally lower than the neighboring grassland in the Nylsvley Nature Reserve. The following woody plants (in order of importance) only contributes about 5-15% canopy cover and do not exceed 5m in height (Van der Meulen, 1979):

Acacia nilotica	71.7
Acacia tortilis	51.7
Acacia karroo	51.7
Rhus pyroides	43.3
Dichrostachys cinerea	43.3
Ziziphus mucronata	43.3

The *Acacia* species occurring in the community have stunted growth forms due to the vertic, black clayey soils. The sweet veld is also highly sought after by grazing animals (Bredenkamp, 1999[b]) and the woody component provides important shelter and shade to many mammal species (Chapter 7). Although not many tourists would be interested in identifying the few trees within this community, the growth form of the stunted *Acacia* species is quite conspicuous (also when in flower) and creates a typical African savanna landscape.

6.4 Conclusion

Although Preston & Fuggle (1988) have shown that the study of plants are significantly behind game viewing or bird watching for tourists, they also noted that limited exposure to subjects influence tourist preferences. Tourists always welcome the chance to be taught about nature on various ecotourist activities (e. g. walking trials, game drives) (Preston & Fuggle, 1988), and therefore the promotion of tree identification as a specialized tourist activity could increase tourist interests for trees.

Trees and shrubs have many interesting features that could be shared with tourists on their visits to game reserves and other ecotourist destinations within the Biosphere Reserve (medicinal properties, browsing value, firewood, arts and crafts). The sharing of these characteristics with tourists might further improve the nature experience for tourists visiting game reserves in the Waterberg Biosphere Reserve, or any other game reserve in southern Africa.

Different tree and shrub species occur under different environmental conditions and within the plant communities of the Waterberg Biosphere Reserve, the species composition varies. However, aspects like species diversity and density, conspicuousness, special characteristics and physical environmental conditions might contribute in determining whether the plant community will be a preferred area for tree identification and other tourist activities. For example, the high tree diversity and aesthetic value of the Kloof Community would probably be preferred by hikers, however the moist conditions within these gorges and ravines (Van Staden (in prep.) make the surface slippery and unsafe. In this instance, guided walks should be conducted into these preferred, but dangerous areas.

Although there is a huge potential to promote the trees and shrubs of the Waterberg Biosphere Reserve as tourist interests, the main aim of most nature reserves within the Biosphere Reserve remains the viewing of wildlife by tourists. Most of the larger mammals occurring within Southern Africa may be encountered on game reserves within the Biosphere Reserve and will be discussed in the following chapter.

Table 6.1 Synoptic table of the trees and shrubs of the Waterberg Biosphere Reserve (Community numbers similar to Chapter 4)

Vegetation type	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Number of releves	**11**	**3**	**43**	**90**	**387**	**156**	**182**	**432**	**44**	**76**	**48**	**5**
Species Group 1												
Podocarpus latifolius			54	9		4						
Myrsine africana			44	1		8						
Celtis africana			40						7	1		
Secamone alpini			37	1	2	1						
Osyris lanceolata			26		2	4			7			
Syzygium cordatum			26		1	5						
Ficus sur			26			1						
Cheilanthes viridis			26	2	8				2			
Acokanthera oppositifolia			23									
Buxus macowanii			23							3		
Tricalysia lanceolata			23		1							
Curtisia dentata			21									
Calpurnia aurea			21						7			
Clutia pulchella			19	3	4	1			2			
Rothmannia capensis			19	7	3	2						
Kirkia wilmsii			19		1				9			
Plectranthus fruticosus			19									
Canthium gilfillanii			19		8		2		5			
Widdringtonia nodiflora			16	6								
Asplenium splendens			16									
Pittosporum viridiflorum			16		1							
Syzygium guineense	9		14		2							
Vepris lanceolata			14									
Cheilanthes viridis	9		14	1	4	1	2		5			
Dovyalis zeyheri			14			3			5	1		
Blechnum attenuatum			12									
Ochna holstii			12									
Grewia occidentalis			12		2				9	1		
Pterocelastrus echinatus			12									
Abrus laevigatus			12		1				2			
Cussonia spicata			12	4	4					1		
Species Group 2												
Ilex mitis	9		21									
Species Group 3												
Anthospermum hispidulum				32			1	2	7			
Protea roupelliae				22								
Passerina montana			7	11								
Rhus magalismontana				10	4		1					
Species Group 4												
Hexalobus monopetalus					18	3			2			
Lantana rugosa				2	16	5	8	8	9	1		
Species Group 5												
Rhus gracillima				8	18	25		4				
Tapiphyllum parvifolium				4	37	13			9			
Combretum nelsonii					12	12	1	4	7			

Species Group 6									
Protea caffra		44	3	37		2	2		
Ancylobotrys capensis	2	10	11	18	3				
Maytenus tenuispina	2	13	40	13	3	8	9	4	
Species Group 7									
Apodytes dimidiata	12	4	8	19			2		
Rhus dentata	16	32	11	18			5		
Olea capensis	14			15			7		
Species Group 8									
Securidaca longepedunculata			1		29			1	
Species Group 9									
Lannea edulis		3	5	16	16	4			
Ximenia caffra			8	11	14	1	9	7	
Species Group 10									
Strychnos pungens		3	46	10	48	9	9		
Vitex pooara			14	6	13	1	9		
Mundulea sericea		2	26	7	13	7	7	4	
Species Group 11									
Terminalia brachystemma			4	1	2	16		5	
Species Group 12									
Lopholaena coriifolia		2	7	23	1	10			
Species Group 13									
Burkea africana	2	8	69	37	80	35	5		
Ochna pulchra		8	36	18	70	17			
Species Group 14									
Schotia brachypetala	9		1			1	27	5	
Bridelia mollis	2		5			3	25	1	
Kirkia acuminata			3			4	21	3	2
Ximenia americana							21		8
Clerodendrum glabrum	5		3	8		6	21		
Spirostachys africana	2						14	5	
Obetia tenax	2						14		
Aloe marlothii			9	3		2	11	3	
Euphorbia cooperi			1				9		
Species Group 15									
Pseudolachnostylis maprouneifolia		1	36	6	3	5	23		
Lannea discolor		3	51	25	36	15	18		
Elephantorrhiza burkei		3	40	36		7	18		4
Gardenia volkensii	5	1	15	11		4	18	4	
Diplorhynchus condylocarpon		1	56	5	9	8	14		
Pterocarpus rotundifolius			25	9	1	17	14		
Rhoicissus revoilii		4	37	21		7	14	7	
Combretum zeyheri			25	12	44	20	14	1	
Strychnos madagascariensis		1	15			4	14		
Species Group 16									
Vitex rehmannii	5	16	41	46	51	22	25		
Ozoroa paniculosa	2	10	40	28	32	12	11		

Species Group 17										
Dombeya rotundifolia		14	3	12	21	39	13	71	7	
Euclea natalensis		12		16	4	34	8	36	9	
Acacia caffra		16	10	5	26	6	16	36	1	
Berchemia zeyheri		12	1	1	1		2	34		
Mimusops zeyheri		19		7	19		2	32	1	
Olea europaea		30			2		2	30		
Euphorbia ingens		26		2				27	1	
Combretum molle		12	12	87	60	55	21	27	1	
Brachylaena rotundata		14	8	11	15			23	1	
Cussonia paniculata		12	1	2				21		
Croton gratissimus		19		24	4	1	4	21	1	
Englerophytum magalismontanum		14	36	66	35	1	4	21	1	
Diospyros whyteana		58	1	7				16		
Vangueria infausta		14	49	39	42	2	5	16		
Rhoicissus tridentata		16	6	5	8		2	16	1	
Ficus thonningii		21	1	2	4		4	14		
Maytenus undata		33	2	3	4			14		
Heteropyxis natalensis	9	19	11	15	22		3	14	1	
Faurea saligna	9	16	13	13	42	4	10	11		
Species Group 18										
Ehretia rigida		9		9		7	7	9	33	
Acacia erubescens							7	2	29	4
Acacia erioloba							2		15	
Acacia burkei						2	4		15	
Maytenus polyacantha		9		1				7	11	
Species Group 19										
Carissa bispinosa		5				3		21	21	
Combretum hereroense				3		1	2	18	20	
Species Group 20										
Grewia flavescens				8	4	55	24	36	43	8
Euclea undulata						13	2	9	29	
Aloe greatheadi v davyana				2		25		2	20	
Species Group 21										
Maytenus heterophylla				5	14	8	7	39	18	2
Euclea crispa		9	2	5	22	3	23	57	13	
Species Group 22										
Terminalia sericea				16	5	76	55	11	18	
Species Group 23										
Rhus leptodictya		12		9	19	13	9	55	21	
Pappea capensis		19		3	4	3	4	68	15	
Diospyros lycioides		12		3	12	12	7	11	11	
Species Group 24										
Commiphora africana								2	1	21
Boscia foetida										20
Ehretia amoena										19
Clerodendrum ternatum										13
Species Group 25										
Acacia mellifera						2	2	7	21	21
Euclea divinorum							2		15	21

Combretum imberbe	2						5	12	13	
Species Group 26										
Acacia nigrescens						2	30	16	69	
Commiphora mollis			3			3	14	3	21	
Sclerocarya birrea			2		2	4	21	4	17	
Boscia albitrunca					1		14	4	17	
Acacia robusta	5					2	14	5	15	
Species Group 27										
Grewia bicolor			5			14	16	34	77	
Grewia flava	2	1	2	1	4	15	39	36	75	
Species Group 28										
Peltophorum africanum			3	3	20	23	23	15	19	
Species Group 29										
Grewia monticola			11	3	9	10	30	18	58	
Combretum apiculatum			19	9	19	27	48	18	38	
Species Group 30										
Acacia nilotica					4	2	2	12	6	60
Acacia tortilis					5	4	7	49	75	20
Species Group 31										
Rhus pyroides	2		1	8	3	12	7	17		20
Acacia karroo				3	3	16	27	40	25	20
Species Group 32										
Dichrostachys cinerea			5	5	48	35	32	66	67	20
Species Group 33										
Ziziphus mucronata	5		10	10	4	21	80	41		20

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Appendix 6.1 Tree and shrub species of the Waterberg Biosphere Reserve and some of their interesting characteristics

Tree / Shrub species	Medicinal / Veterinary	Food Source	Wood / leaf/ bark use	Diagnostic	Conspicious	Total / 6	Total / 5
Acacia burkei	1	1	1	1	2	6	5.00
Acacia caffra	1	1	1	0	2	5	4.17
Acacia erioloba	1	1	1	1	2	6	5.00
Acacia erubescens	0	1	1	1	1	4	3.33
Acacia karroo	1	1	1	0	2	5	4.17
Acacia mellifera	1	1	1	0	1	4	3.33
Acacia nigrescens	0	1	1	0	2	4	3.33
Acacia nilotica	1	1	1	0	2	5	4.17
Acacia robusta	0	1	0	0	1	2	1.67
Acacia tortilis	1	1	1	0	2	5	4.17
Acokanthera oppositifolia	1	0	1	1	1	4	3.33
Aloe marlothii	1	1	1	1	2	6	5.00
Ancylobotrys capensis	0	1	0	0	0	1	0.83
Apodytes dimidiata	1	1	1	0	2	5	4.17
Berchemia zeyheri	1	1	1	0	1	4	3.33
Boscia albitrunca	1	1	1	0	1	4	3.33
Boscia foetida	1	1	1	1	1	5	4.17
Brachylaena rotundata	1	1	1	0	2	5	4.17
Bridelia mollis	1	1	0	1	1	4	3.33
Burkea africana	1	1	1	0	1	4	3.33
Buxus macowanii	0	1	1	1	1	4	3.33
Calpurnia aurea	1	1	1	1	1	5	4.17
Canthium gilfillanii	1	0	1	1	0	3	2.50
Celtis africana	0	1	1	1	2	5	4.17
Clerodendrum glabrum	1	1	1	1	2	6	5.00
Clutia pulchella	0	0	0	1	2	3	2.50
Combretum apiculatum	1	1	1	0	1	4	3.33
Combretum hereroense	1	1	1	0	1	4	3.33

Tree / Shrub species	Medicinal / Veterinary	Food Source	Wood / leaf/ bark use	Diagnostic	Conspicuous	Total / 6	Total / 5
Combretum imberbe	1	1	1	0	1	4	3.33
Combretum molle	1	1	1	0	1	4	3.33
Combretum nelsonii	1	1	1	0	2	5	4.17
Combretum zeyheri	1	1	1	0	1	4	3.33
Commiphora africana	1	1	1	1	1	5	4.17
Commiphora mollis	0	1	1	0	1	3	2.50
Croton gratissimus	1	1	1	0	1	4	3.33
Curtisia dentata	1	0	1	1	2	5	4.17
Cussonia paniculata	1	1	1	0	1	4	3.33
Cussonia spicata	1	1	1	1	1	5	4.17
Dichrostachys cinerea	1	1	1	0	1	4	3.33
Diospyros lycioides	1	1	1	0	0	3	2.50
Diospyros whyteana	1	1	1	0	1	4	3.33
Diplorhynchus condylocarpon	1	1	1	0	1	4	3.33
Dombeya rotundifolia	1	1	1	0	2	5	4.17
Dovyalis zeyheri	0	1	1	1	1	4	3.33
Ehretia amoena	0	1	0	1	1	3	2.50
Ehretia rigida	1	1	1	1	1	5	4.17
Elephantorrhiza burkei	1	1	1	0	2	5	4.17
Englerophytum magalismontanum	1	1	0	0	1	3	2.50
Euclea crispa	1	1	1	0	1	4	3.33
Euclea divinorum	1	1	1	0	1	4	3.33
Euclea natalensis	1	1	1	0	1	4	3.33
Euclea undulata	1	1	1	0	1	4	3.33
Euphorbia cooperi	0	0	1	1	1	3	2.50
Euphorbia ingens	1	0	0	0	1	2	1.67
Faurea saligna	1	0	1	0	2	4	3.33
Ficus sur	1	1	1	1	1	5	4.17
Ficus thonningii	1	1	1	0	1	4	3.33
Gardenia volkensii	1	1	1	0	2	5	4.17

Tree / Shrub species	Medicinal / Veterinary	Food Source	Wood / leaf/ bark use	Diagnostic	Conspicious	Total / 6	Total / 5
Grewia bicolor	1	1	1	0	1	4	3.33
Grewia flava	1	1	1	0	1	4	3.33
Grewia flavescens	0	1	1	0	1	3	2.50
Grewia monticola	0	1	1	0	1	3	2.50
Grewia occidentalis	1	1	1	1	0	4	3.33
Gymnosporia buxifolia	1	0	1	0	0	2	1.67
Gymnosporia polyacantha	1	0	1	1	0	3	2.50
Heteropyxis natalensis	1	1	0	0	1	3	2.50
Hexalobus monopetalus	0	1	0	1	0	2	1.67
Ilex mitis	1	1	1	1	1	5	4.17
Kirkia acuminata	1	1	1	1	2	6	5.00
Kirkia wilmsii	1	1	1	1	1	5	4.17
Lannea discolor	1	1	1	0	2	5	4.17
Maytenus tenuispina	1	0	0	0	0	1	0.83
Maytenus undata	0	0	1	0	1	2	1.67
Mimusops zeyheri	0	1	1	0	1	3	2.50
Mundulea sericea	1	1	1	0	2	5	4.17
Myrsine africana	0	1	0	1	0	2	1.67
Obetia tenax	1	0	1	1	1	4	3.33
Ochna holstii	0	1	1	1	0	3	2.50
Ochna pulchra	0	1	1	0	2	4	3.33
Olea capensis	0	0	1	0	2	3	2.50
Olea europea	1	1	1	0	1	4	3.33
Osyris lanceolata	0	0	1	1	1	3	2.50
Ozoroa paniculosa	1	1	1	0	1	4	3.33
Pappea capensis	1	1	1	0	1	4	3.33
Peltophorum africanum	1	1	1	0	2	5	4.17
Pittosporum viridiflorum	1	1	0	1	1	4	3.33
Podocarpus latifolius	0	1	1	1	2	5	4.17
Protea caffra	1	1	1	0	2	5	4.17

Tree / Shrub species	Medicinal / Veterinary	Food Source	Wood / leaf/ bark use	Diagnostic	Conspicious	Total / 6	Total / 5
Protea roupelliae	1	1	0	1	2	5	4.17
Pseudolachnostylis maprouneifolia	1	1	1	0	1	4	3.33
Pterocarpus rotundifolius	1	1	1	0	2	5	4.17
Pterocelastrus echinatus	1	0	1	1	1	4	3.33
Rhoicissus revoilii	0	1	1	0	0	2	1.67
Rhus dentata	0	1	1	0	1	3	2.50
Rhus leptodictya	1	1	1	0	1	4	3.33
Rhus pyroides	1	1	1	0	1	4	3.33
Rothmannia capensis	1	1	1	1	2	6	5.00
Schotia brachypetala	1	1	1	1	2	6	5.00
Sclerocarya birrea	1	1	1	0	2	5	4.17
Securidaca longepedunculata	1	0	1	1	1	4	3.33
Spirostachys africana	1	1	1	1	1	5	4.17
Strychnos cocculoides	1	1	1	1	2	6	5.00
Strychnos madagascariensis	0	1	0	0	1	2	1.67
Strychnos pungens	1	1	0	0	1	3	2.50
Syzygium cordatum	1	1	1	1	2	6	5.00
Syzygium guineense	1	1	1	1	1	5	4.17
Tapiphyllum parvifolium	0	1	1	0	1	3	2.50
Terminalia brachystemma	1	1	1	1	1	5	4.17
Terminalia sericea	1	1	1	0	2	5	4.17
Tricalysia lanceolata	0	0	0	1	0	1	0.83
Vangueria infausta	1	1	1	0	1	4	3.33
Vepris lanceolata	1	1	1	1	0	4	3.33
Vitex pooara	1	1	1	1	1	5	4.17
Vitex rehmannii	1	1	1	0	1	4	3.33
Widdringtonia nodiflora	0	0	1	1	1	3	2.50
Ximenia americana	1	1	1	1	1	5	4.17
Ximenia caffra	1	1	1	0	1	4	3.33
Ziziphus mucronata	1	1	1	0	1	4	3.33

CHAPTER 7

HABITAT TYPES OF LARGER MAMMALS IN THE WATERBERG BIOSPHERE RESERVE

7.1 Introduction

Ecotourism as an integral part of game ranching in the Limpopo Province, South Africa, earns foreign currency and contributes significantly to the economy of the Limpopo Province (Van der Waal & Dekker, 2000). Game viewing is regarded as the most popular tourist activity within game reserves in Southern Africa (Preston & Fuggle, 1988). Barnes *et al.* (1999) showed that tourists are willing to pay for wildlife viewing and wildlife conservation in Namibia, while Norris (1992) noted that 30 million Americans participated in wildlife viewing during 1991. Tourist will even be willing to pay to see only a single species, as shown by Harrison (1992).

However, the conservation of the mammal species viewed by tourists within nature reserves should still receive priority. Siegfried & Brown (1992) noted that the distribution of resident terrestrial mammalian species of southern Africa, indicates that the existing arrangement of nature reserves in the region corresponds closely with an ideal (hypothetical) configuration for maximizing protection of this fauna.

The number of mammal species supported by a plant community depends on several factors like the primary production, seasonal availability of resources, floral heterogeneity, diversity of plant structure, nature of the substratum and previous history (Delany, 1982). Each mammal species have a particular niche, which can be regarded as the sum of all ecological requirements of a species namely food, space, shelter and physical conditions. Mills & Hes (1997) stated that the distribution and abundance of animal species does not rigorously follow that of plant communities or biomes. Instead, mammal species seem to have certain preferences for a specific habitat type (Skinner & Smithers, 1990). Several authors have shown this preference of mammals to certain habitats through analysis (Beardall *et al.* 1984; Ben-Shahar, 1991; Dekker *et al.* 1996).

The aim of this chapter is to identify and classify the major habitat types of the larger mammals within the Waterberg Biosphere Reserve, and to show the importance of the threatened species' conservation. Descriptions of the habitat types are done according to habitat preferences of mammals. However, since habitat types of mammals consist of different overlapping plant communities (discussed in following sections), the specific value of certain plant species for grazing or browsing are not included. The main theme remains the value these mammals have for the tourism industry.

7.2 Methods

7.2.1 Mammal database

A database of the larger mammals occurring on game reserves, the Marakele National Park and other wilderness areas within the Waterberg Biosphere Reserve was created. Data sets were obtained from the following sources:

- Mammals occurring within quarter degree grid cells (15' X 15' ~ 700 km^2) within the Waterberg Biosphere Reserve were obtained from the Conservation Planning Unit, Department of Zoology and Entomology, University of Pretoria.
- Mammal lists were obtained from the game reserves and national park visited in the Waterberg Biosphere Reserve as listed in Chapter 5.

The mammals selected for the database were chosen as having the potential to be viewed by tourists visiting the game reserves and national park. Therefore smaller mammals (e. g. shrews, mice, rats and bats) not regularly sighted by tourists, were discarded when the database was created. Only when a smaller mammal species was considered to be of particular interest and tourists would possibly be interested in viewing them when sighted, the species was included in the database (e. g. Banded mongoose, dwarf mongoose, pangolin, rock dassie). However, some of the mammals are threatened and needs conservation management strategies, therefore the conservation status of the mammal species is included in Appendix 7.2, while a full description of the different categories is included in Appendix 7.3 as adapted from from Hilton-Taylor (2000).

7.2.2 Habitat preferences of mammals

Habitat preferences of mammals occurring within the Waterberg Biosphere Reserve were obtained from Skinner & Smithers (1990) and Mills & Hes (1997). These data were added to the database. The habitat preferences were linked to the 12 major plant communities identified in the Waterberg Biosphere Reserve (Chapter 4) by comparing the description of the plant communities (Chapter 4) to the description by Skinner & Smithers (1990) and Mills & Hes (1997). The mammal species list and habitat preferences are included as Appendix 7.1.

7.2.3 Habitat Classification and Identification

Habitat classification of the mammals was done using a Two-Way-Species-Indicator-Analysis (TWINSPAN) (Hill, 1979). In TWINSPAN the following parameters were used during classification:

- ◊ Cutlevels for cover abundance: 0 - 2 - 10 - 25 - 50
- ◊ Maximum level of divisions: 3
- ◊ Other parameters were left default although the option to visualize the cluster hierarchy was selected

The plant communities (Chapter 4) used during the TWINSPAN classification procedures as habitat types for mammals, were used similar to synrelevés in the classification of large vegetation datasets (Bredenkamp & Bezuidenhout, 1995). Although no cover abundance or constancy values were used for the mammals, as done with vegetation classification, the presence of a mammal species in a plant community was indicated as 1. However, mammal species may occur in more than one plant community, and was indicated accordingly in Table 7.2.

The TWINSPAN classification revealed 5 different habitat types for mammals within the Waterberg Biosphere Reserve, from which a classification table similar to a Braun-Blanquet table (Kent & Coker, 1996) for vegetation classification was created. This table showed which combination of plant communities in the Waterberg

Biosphere Reserve forms a preferred habitat to specific mammal species. A synoptic table was also created to show the new habitat types identified as well as the diagnostic mammal species within it.

The habitat types were described after TWINSPAN classification according to mammal species composition and habitat characteristics (e. g. plants valuable for browsing / grazing within habitat).

7.3 Results and Discussion

7.3.1 Classification Hierarchy

Figure 7.1 represent the classification hierarchy of the habitat types of the mammal species occurring within the Waterberg Biosphere Reserve as follows:

- The first level of division for mammal habitat types were the separation of the mammals inhabiting land as their dominant habitat type and the typical water-inhabiting mammals, only occasionally seen feeding on land.
- The land mammal species are divided on a second level into mammals occurring within broken, rugged terrain and mammals inhabiting a flatter, more open terrain within the Waterberg Biosphere Reserve.
- The mammal species associated with the more open plains are divided on a third level into mammal associated with two habitat types, namely grassland associated species, and savanna woodland associated species. Vegetation structure play a major role in habitat selection by mammal species occurring in these habitats types (Delany, 1982; Ben Shahar, 1991; Gros & Rejmanek, 1999; Dörgeloh, 2001), especially providing shelter to the smaller cats (e. g. serval, caracal, african wild cat) and herbivores (e. g. steenbok, scrub hare).
- The mammal species of the more rugged terrain are separated on a third level based primarily on physical habitat and vegetation structure. The first group represent the rocky mountain slopes of the mountainous areas within the Waterberg Biosphere Reserve, while the second group represents a dense vegetation habitat (e. g. Termitaria, encroached areas, kloof forests, riverine

vegetation and vegetation associated with dolerite / diabase dykes) dominated by woody species with very little undergrowth.

7.3.2 Description of the large mammal habitat types

The habitat types described here represent the areas within which tourists are most likely to see the mammal species. The mammals may also be spotted in other habitat types, but the habitat types in which they are described represent the habitat preference of the mammal in terms of food, space, shelter and physical conditions (Delaney, 1982). The habitat types do not only show the possibility for tourists to view the mammals, but also provide the basis for reserve managers to identify habitat types on their properties if they want to relocate certain mammal species. The plant community preference of a mammal species within a habitat type may also be described as an example of specialist feeding. However, this only indicates the most favorable habitat of the animal, and tourists on certain properties may view these animals in completely different habitat types if the animals were relocated on properties with unfavorable habitat types for the mammal species (e. g. gemsbok within moist environments). The synoptic table (Table 7.1) shows the frequencies of mammal species within the habitat types, and the "Braun-Blanquet" table (Table 7.2) show which plant communities (Chapter 4) represent the habitat types. Once the scientific names of mammals were mentioned within the habitat descriptions, their common names are used onwards in the chapter. The positions of the mammal species in the tables (e. g. Species Group 2, Table 7.1) are also only once referred to.

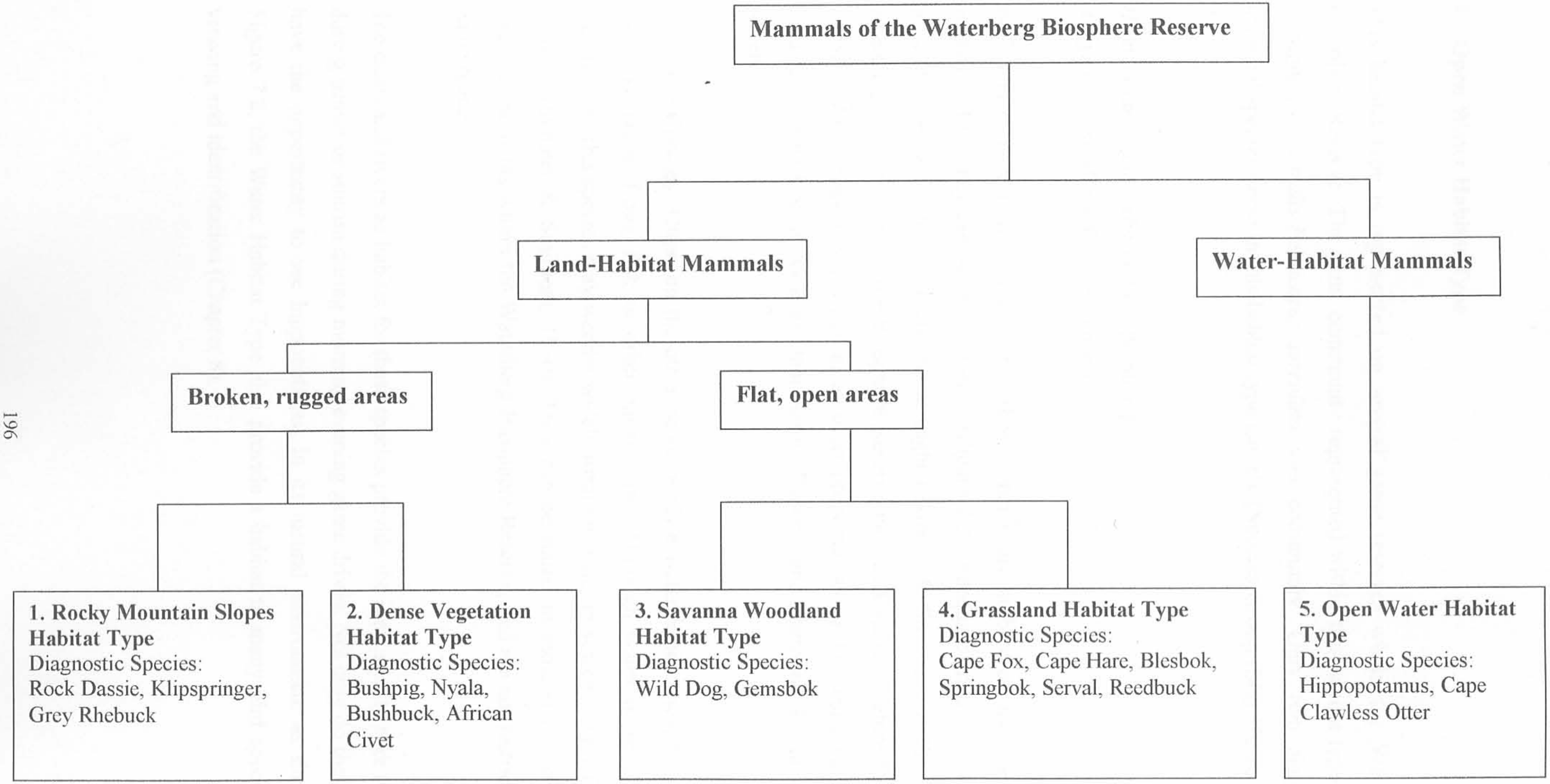

Figure 7.1. Dendrogram presenting TWINSPAN hierarchy of Waterberg Biosphere Reserve mammal habitat types

1. Open Water Habitat Type

This habitat type is represented on several game reserves within the Waterberg Biosphere Reserve. The plant community represented within this habitat type is the *Phragmites australis-Persicaria serrulata* vlei community. Only two diagnostic mammal species occur in this habitat type namely [Species Group (SG) 10, Table (T) 7.1:

Hippopotamus amphibius (Hippopotamus)
Aonyx capensis (Cape Clawless Otter)

Both species need open surface water. Hippopotamus are herbivores that need open water in which they can submerge totally (Figure 7.2). Adequate grass close to their water habitat is essential for grazing at night (Skinner & Smithers, 1990). Places where hippos occur within the Biosphere Reserve include Entabeni Nature Reserve, Lapalala Wilderness Area (as well as all other properties along the Lephalala River), Emaweni Game Lodge, Mokolo Dam Nature Reserve and Shambala Private Game Reserve.

The Cape Clawless Otter, on the other hand, needs a water habitat, which supplies food like crabs, frogs, fish or other aquatic life. Although water is an essential requirement, this species may wander widely from the water in search of new feeding grounds (Skinner & Smithers, 1990). They can be found in most rivers, streams, swamps and dams within the Waterberg Biosphere Reserve, and are not restricted by game fences.

The dams and rivers as habitat for these species provide the ideal spot to take tourists during sunset or sunrise during morning/evening game drives. Not only do the tourist have the opportunity to see hippopotamus in its natural environment as shown in Figure 7.2, the Water Habitat Type also provide a habitat to many bird species for viewing and identification (Chapter 8).

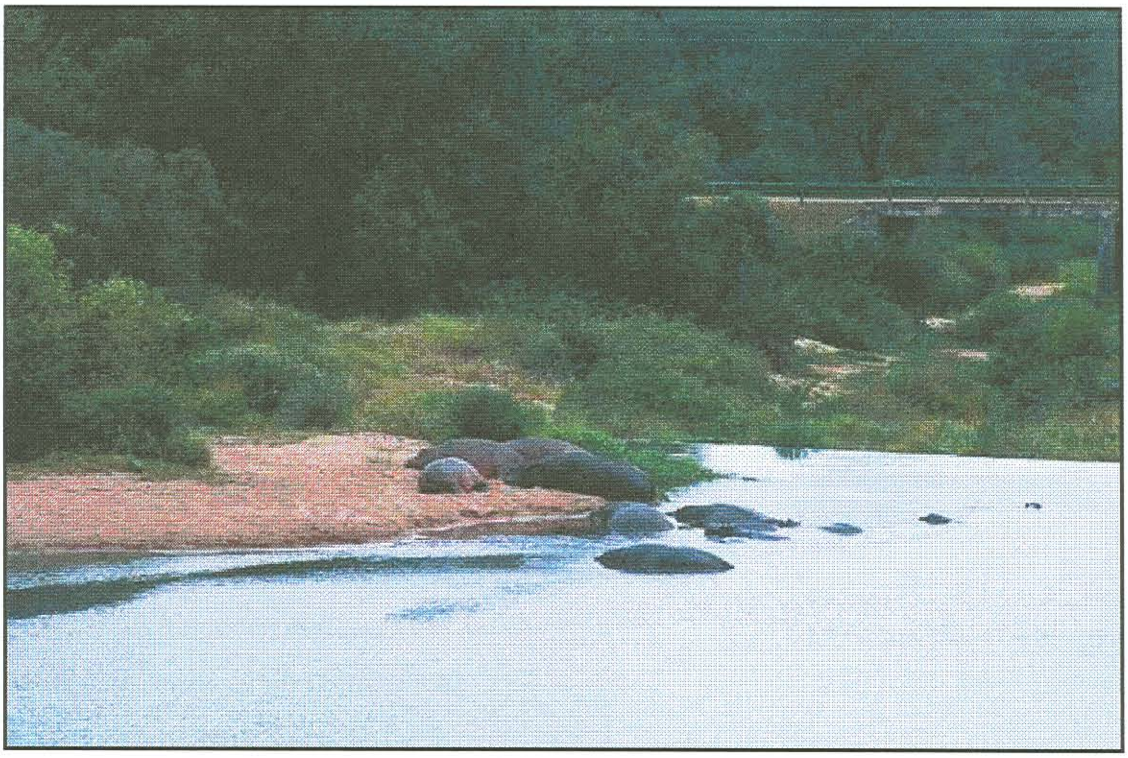

Figure 7.2 Typical Open Water Habitat suitable for hippopotamus. Hippopotamus need open water to totally submerge and several game reserves have relocated hippopotamus within the Biosphere Reserve.

2. Grassland Habitat Type

This habitat type is represented in three different plant communities described in Chapter 4, namely the *Fuirena pubescens-Andropogon huilensis* sponge community, *Cynodon dactylon-Dichrostachys cinerea* old fields community (early variation) and the *Setaria incrassata-Aristida bipartita* vertic clay community. The vegetation structure plays a major role within this habitat type in providing the necessary shelter and food to the mammal species. The structure is mostly a closed grassland (Edwards, 1983). The following species are diagnostic to the habitat type (SG 6, T 7.1):

Vulpes chama (Cape Fox)
Lepus capensis (Cape Hare)
Damaliscus pyrgarus phillipsi (Blesbok)
Antidorcas marsupialis (Springbok)
Redunca arundinum (Reedbuck)
Leptailurus serval (Serval)

The springbok and blesbok are classified as lower risk species, dependent on conservation (Hilton-Taylor, 2000). However, considering the many conservation areas in the Waterberg Biosphere Reserve, the species are under no immediate threat. Species like the cape hare, springbok and blesbok are confined only to old field plant communities described by Furniss (1998), Joubert (1998) and Newberry (1998) within the Waterberg Biosphere Reserve. The springbok and blesbok antelope species occurring on game reserves within the Waterberg Biosphere Reserve were introduced by game farmers and reserve managers to their properties, since the species did not occur in the Waterberg area in the past. The old fields created a valuable opportunity to game farmers to introduce these species into the habitat type as shown in Figure 7.3. Joubert (1998) noted that these old fields are also particularly favoured by large grazing species such as blue wildebeest (*Connochaetes taurinus)*, burchell's zebra (*Equus burchellii*), red hartebeest (*Alcelaphus buselaphus*) (lower risk species), tsessebe (*Damaliscus lunatus*), impala (*Aepyceros melampus*) and white rhinoceros (*Ceratotherium simum*) (lower risk, conservation dependent) (SG 7, T 7.2). Short-legged grazing mammals species such as warthogs and steenbok (SG 7, T 7.1) prefer the short grassland variation of old fields, so they can keep a proper lookout for predators (Eltringham, 1979). Fire further plays a major role in maintaining the grass cover of the old fields, as well as preventing the succession from developing beyond the grassland stage to undesirable thicket (Tainton, 1981). However, applying a burning program to these areas should consider factors such as overgrazing, drought, rainfall and available plant material (Brown, 1997).

The other plant communities represented in this habitat type include the sponge community and seasonally flooded grassland community located within the Marakele National Park and Nylsvley Nature Reserve respectively. Coetzee *et al.* (1976) described the floodplain area of Nylsvley Nature Reserve as mainly grassland, with an open stand of thorn savanna in areas where the water table is generally lower than in the grassland. These floodplains provide an important habitat for one of the most important natural breeding herds of the rare *Hippotragus equinus* (roan antelope; SG 7, T 7.2) (Dörgeloh, 1998). Both the sponge and floodplain communities are seasonally flooded and extremely sensitive to burning. Van Staden (in prep.) recommend that wetland areas in the Marakele National Park be burned alternatively every three years to prevent encroachment of woody species into the wetlands. Too frequent burning of these wetland areas would attract large numbers of grazing animals causing compaction of the soil and erosion (Van Staden, in prep.).

The Grassland Habitat Type further provides the ideal habitat for nocturnal specialized insect feeders like the aardvark (*Orycteropus afer*), aardwolf (*Proteles cristatus*), bat-eared fox (*Otocyon megalotis*) (SG 8, T 7.1) and pangolin (*Manis temminckii*) (SG 9, T 7.1), mostly being termite feeders (Skinner & Smithers, 1990). These animals are shy animals and rarely seen when night drives are provided to tourists on private game reserves such as Welgevonden Private Game Reserve, Entabeni Nature Reserve, Shambala Private Game Reserve. Longer exposure of these animals to game drive vehicles and floodlights at night might yield sightings that are more regular.

Furthermore, the grassland habitat provides the ideal habitat for prey species (e. g. shrews, mice, rats and several bird species) for the smaller nocturnal cats like caracal (*Caracal caracal*) (SG 7, T 7.1), serval (*Leptailurus serval*), african wild cat (*Felis lybica*) (SG 9, T 7.1), as well as the two south African jackal species [black backed jackal (*Canis mesomelas*) SG 7, T 7.1) and side-striped jackal (*Canis adutus*), SG 8, T 7.1] and fox species (Cape Fox). Other typical prey species of these small predators within this habitat type include scrub hare (*Lepus saxatilis*) and springhare (*Pedetes capensis*) (SG 7, T 7.1). The only large predator occurring within the Grassland Habitat Type is the cheetah (*Acinonyx jubatus*) (SG 7, T 7.1), preferring open areas with adequate prey species like impala (Skinner & Smithers, 1990). Not many cheetahs occur within conservation areas in the Waterberg Biosphere Reserve, and their vulnerable conservation status (Hilton-Taylor, 2000) need to be seriously considered within conservation monitoring programs. The predators and insect-eating carnivores described above may occur throughout grasslands in the Waterberg Biosphere Reserve and are not restricted by fences.

The Grassland Habitat Type is the most suitable habitat for easy game viewing by tourists visiting reserves like the Nylsvlei Nature Reserve and old field areas in other reserves within the Biosphere Reserve. However, tall grass and reedbeds might hamper viewing in floodplain areas and secondary old fields during the warm summer months (growing season). The predators within this habitat type are mostly nocturnal, except the cheetah, and if night drives are provided tourists might see these animals (e. g. serval, caracal, african wild cat, jackal species) (Figure 7.4). Rare grazing species like reedbuck, roan and tsessebe also occur here, as well as grazers that are more common (blue wildebeest, Burchell's zebra, impala, blesbok and white rhinoceros). The open habitat type provides the ideal opportunity for day and night drive activities, and guided walking safaris.

It should however be emphasized that the different plant communities within this habitat type, have different plant species composition, resulting in differences in grazing capacity (Van Staden, in prep.; Newberry, 1998; Bothma, 2000), which in turn will influence the numbers of animals it can support. This will influence veld management strategies, which is not addressed in this study.

Figure 7.3 Blesbok seen on the old fields at Jobedi Game Lodge. The old fields provide an added man-made habitat to blesbok in the Waterberg Biosphere Reserve.

Figure 7.4 Small predators like serval occur within the Grassland Habitat Type in the vicinity of water.

3. Savanna Woodland Habitat Type

This habitat type is typical of the savanna woodlands of the low-lying and flat areas within the Waterberg Biosphere Reserve. One of the most important facts out of a tourist's point of view is that it has the potential (and in some locations like the Welgevonden Private Game Reserve, it does) to host the big five (lion, elephant, rhinoceros, buffalo and elephant). Three different plant communities provide habitats to mammals namely the *Terminalia sericea-Eragrostis pallens* deep sand community, the *Burkea africana-Setaria sphacelata* community of foothills, undulating plains and terraces, and the *Acacia nigrescens-Grewia flava* plains community (Chapter 4). The savanna woodland of southern Africa occupies the major portion of the subcontinent. It varies widely between two principal types - the arid "sweet" bushveld and the moist "sour" bushveld types. The distinction is reflected in the degree to which the nutritional (grazing) value of grasses, shrubs and trees of these two savanna woodland types is maintained into the long, dry winter (Mills & Hes, 1997). Two diagnostic mammal species occur within this habitat type as follows (SG 3, T 7.1):

Lycaon pictus (Wild dog)
Oryx gazella (Gemsbok)

The wild dog is listed in the South African Red Data List as endangered species (Hilton-Taylor, 2000), and the occurrence of free-roaming packs of wild dogs is extremely rare, although they are occasionally seen. Reich (1977) found that their home ranges within the Kruger National Park are as large as 450 km^2. However, wild dogs have been relocated recently on the Shamabala Private Game Reserve and Marakele National Park within the Biosphere Reserve, and the potential of these fascinating predators for tourism could be hugely beneficial to the large reserves within the Biosphere Reserve.

Gemsbok are essentially a species of open, arid country (Skinner & Smithers, 1990), and due the lack of many of such conservation areas in South Africa, they are classified as lower risk species, dependent on conservation. Although game reserves and game farmers do have gemsbok on their properties within the Sour Bushveld Veld Type (Acocks, 1988), these areas are not suitable habitat and they are better adapted for the Arid Sweet Busveld (Acocks, 1988) areas to the north of the Biosphere Reserve. Reserves like the Wonderkop Nature Reserve, Keta Private Nature Reserve and Masebe Nature Reserve provides the suitable habitat for gemsbok.

Several herbivores occur within this Savanna Woodland habitat type, and are separated into grazers (grass-eating species) or browsers (leaf-eating species) (Eltringham, 1979). Grazers, browsers or grazer-browser species (e. g. impala, eland, elephant) occurring typically within the plains of the *Acacia nigrescens-Grewia flava* community (Chapter 4), are typical arid savanna species like elephant *(Loxodonta africana*), black rhinoceros (*Diceros bicornis minor*) (SG 4, T 7.2), kudu (*Tragelaphus strepsiceros*), buffalo (*Syncerus caffer*), blue wildebeest, Burchell's zebra, impala (SG 7, T 7.1) and giraffe (SG 8, T 7.1) (*Giraffa camelopardalis*) (Mills & Hes, 1997). Typical arid areas where some of these species can be seen within the Waterberg Biosphere Reserve include the Marakele National Park and Wonderkop Nature Reserve.

The other two plant communities occur mostly within the Waterberg Mountain range and usually carry soils that are poor in nutrients and occasionally waterlogged during the rainy season. The vegetation is subsequently of low nutritive value and low density ungulate species such as roan antelope and sable antelope do occur here (Mills & Hes, 1997). White rhinoceros, red hartebeest and tsessebe, all being classified as lower risk species occur on the low-lying areas (*Terminalia sericea-Eragrostis pallens* community, Chapter 4) of conservation areas, while species like chacma baboon, mountain reedbuck and Jameson's red rock rabbit can be seen on the rocky terraces and undulating plains. Bothma (2000) noted that rare antelope species like sable antelope (lower risk species, conservation dependent) and roan antelope can be utilized commercially in breeding programs, and many game farmers have recognized game ranching as an agricultural enterprise in the Limpopo Province (Van der Waal & Dekker, 2000).

Predators are specialized mammal species, and can be of great value on large game farms and reserves in controlling ungulate numbers (Bothma, 2000). Several predator species (including the big cat species lion, leopard and cheetah) occur within this habitat type. Leopards roam freely in the Waterberg, and Grimbeeck (1991) observed that leopard density and distribution patterns within the Waterberg area are relatively safe. Leopards occur throughout the Waterberg Biosphere Reserve, and although rarely seen by tourists, they may be seen more regularly if game drives (day and night) are provided so that these cats can become used to the game drive vehicles. Reports by guides on the Welgevonden Private Game Reserve have in fact confirmed that leopards are seen more regularly when exposed to game drive vehicles and floodlights (Kilian, pers. comm.). The vulnerable (Hilton-Taylor, 2000) lion occurs in the Welgevonden Private Game Reserve, Touchstone Game Lodge, Shambala Private Game Reserve and Entabeni Game Reserve within the Biosphere Reserve (Figure 7.5). They need to be implemented as part of a special conservation strategy on reserves where they occur. Lion occur in a wide range of habitats mostly dependent on the availability of prey species (Skinner & Smithers, 1990). Although cheetah prefers open areas for hunting, Gros & Rejmanek (1999) noted that cheetah prefers habitats with a 25-50% woody cover and grasses of medium height in Uganda, similar to this habitat type. Cheetahs have been relocated on places such as the Welgevonden Private Game Reserve and Shambala Private Game Reserve, yet wild individuals roam the Waterberg Biosphere Reserve and are occasionally seen by tourists on game reserves. The other large predators, although mostly scavenging, include the brown hyaena (*Parahyaena brunnea*) (SG 5, T 7.1), occurring mostly within the sour bushveld communities described above, and the spotted hyaena (*Crocuta crocuta*) (SG 7, T 7.1), occurring on the arid sweet plains, although being rarely seen. Hilton-Taylor (2000) classifies both of these species as lower risk species dependent on conservation areas. The lack of many conservation areas on the arid sweet plains makes the presence of the spotted hyaena highly unlikely, although individuals may occur. This is totally different for the brown hyaena, which thrives in the many reserves within the moist mountainous areas. Other smaller nocturnal predators occurring within this habitat type and could possibly be seen on night drives offered by game reserves include large spotted genet, small spotted genet (arid areas) (SG 5, T 7.1), caracal, black backed jackal (SG 7, T 7.1), sidestriped jackal (SG 8, T 7.1) and african wild cat (SG 9, T 7.1).

This habitat type provides an excellent opportunity for tourists to see most of the grazer species in the Waterberg Biosphere Reserve. The open woodland vegetation structure provides excellent viewing of species such as blue wildebeest. This habitat can also host the "Big Five" (if present on the reserve). It is also quite suitable for short, easy guided walks on reserves. Nocturnal animals and predators abound and night drive activities through these areas are recommended for tourists.

Figure 7.5 Lion prefers the Savanna Woodland Habitat Type since prey species abound within it. The relocation of lion to larger reserves within the Waterberg Biosphere will certainly play a major part in increasing foreign tourist visits.

4. Dense Vegetation Habitat Type

This habitat type is represented as patches of vegetation within the Waterberg Biosphere Reserve. Three different plant communities identified in Chapter 4 are represented in this habitat type namely the kloof forest community (*Podocarpus latifolius-Diospyros whyteana*), termitaria and encroached areas community (*Acacia tortilis-Panicum maximum-Ziziphus mucronata*) and the sweet diabase/dolerite community (*Dombeya rotundifolia-Panicum maximum*). These communities have a dense woody component, although the undergrowth cover is low, especially in encroached areas and kloofs. Herbivores occurring in this habitat type are browsers, or both browsers and grazers. The following mammal species are diagnostic (SG 3, T 7.1):

Potamochoerus larvatus (Bushpig)
Tragelaphus angassi (Nyala)
Tragelaphus scriptus (Bushbuck)
Civettictis civetta (African Civet)

The bushpig and African civet are strictly nocturnal animals and omnivorous and carnivorous respectively (Skinner & Smithers, 1990). They are rarely seen, although the African civet are known to be in the vacinity of chalets and camping sites situated along riverine areas. The nyala and bushbuck are often in competition for the same habitat along riverine or forested areas. The nyala (classified as a lower risk, conservation dependent species) is mostly diurnal and browser-grazers, whilst bushbuck browses and is nocturnal in undisturbed areas, although they will also browse during the day (Skinner & Smithers, 1990). Both these species are extremely shy, though are more regularly sited when introduced on game ranches.

Other typical herbivore species preferring this habitat type include elephant, black rhinoceros, common duiker (*Sylvicapra grimmia*) (SG 4, T 7.1) and kudu (SG 5, T 7.1) (Skinner & Smithers, 1990). The encroached areas on the plains within the Marakele National Park (Fig. 7.7) seem to be preferred by both black rhinoceros and elephant (Engelbrecht, pers. comm). However, both these species need to be incorporated in a monitoring and management plan of reserves, especially elephant which requires a certain habitat (Bothma, 2000). Although the Waterberg area does not provide the most suitable habitat for black rhinoceros, they are selective feeders (Muya & Oguge, 2000), and the presence of a dolerite/diabase dyke on a large reserve or game farm might provide an added preferred habitat for the possible introduction of black rhinoceros. Other reserves where they can be seen within the Waterberg Biosphere Reserve include Lapalala Wilderness and Shambala Private Nature Reserve. The black rhinoceros are classified as critically endangered and the elephant as endangered by Hilton-Taylor (2000) and therefore need to be implemented as part of a conservation management strategy if present on reserves. In addition to tall closed woodland preferred by elephant (like kloof vegetation), as shown by Gertenbach (1987) in the Kruger National Park, they also utilize termitarium vegetation (Ruggiero & Fay, 1994). The presence of elephant on game reserves, as one of "The Big Five", could be vital in increasing tourism in the Biosphere Reserve. They have been introduced on most of the big reserves in the Biosphere Reserve (e. g. Entabeni Game Reserve, Marakele National Park, Lapalala Wilderness, Kwalata Game Lodge, Touchstone Game Lodge, Welgevonden Game Reserve and Shambala Private Nature Reserve).

Giraffe (SG 8, T 7.1) often browse the leaves of Acacia species occurring on termitaria, especially in open areas such as in the Nylsvlei Nature Reserve, whilst tree squirrels (*Paraxerus cepapi*), chacma baboon and vervet monkeys (*Chlorocebus mitis*) (SG 5, T 7.1) utilize the available fruits, seeds and gum from tree species such as *Pappea capensis, Acacia* species and *Grewia* species growing on termitaria (Chapter 6). Smaller carnivorous species like dwarf mongoose (*Helogale parvula*) (SG 8, T 7.1) and banded mongoose (*Mungos mungo*) (SG 4, T 7.1) use termitaria both as habitat and as feeding site, being carnivorous (Skinner & Smithers, 1990). Other animals like common duiker (SG 4, T 7.1) and nyala use termitaria vegetation mostly as shelter.

Nocturnal animals and predators especially associated with this dense vegetation structure include the thicktailed bushbaby, south African lesser bushbaby (SG 4, T 7.1), both genet species, leopard (SG 5, T 7.1), side-striped jackal (SG 8, T 7.1), African wild cat and lion (SG 9, T 7.1). Leopards and African wild cats use these thickets and riverine areas to hunt, and stalk their prey, whilst lion often rest in these thickets (excluding kloof forest). The bushbaby- and genet species feed mostly on the insects occurring in the scanty undergrowth (Skinner & Smithers, 1990). Other nocturnal mammals with wide habitat tolerances (Skinner & Smithers, 1990) that may be sighted within this habitat type are porcupine (*Hystrix africaeaustralis*), pangolin, honey badger (*Mellivora capensis*) and striped polecat (*Ictonyx striatus)* (SG 9, T 7.1).

This habitat type is very dense and it is difficult to view these mammal species. These areas should be approached quietly and slowly by guides to prevent scaring of animals and for increased viewing chance, whether in a game drive vehicle or on foot. Dangerous animals like elephant and black rhinoceros often occur in this habitat type, and therefore these areas should be assessed before entering, during guided walks. Mostly browsers or browser-grazers (like black rhinoceros, elephant, bushbuck and nyala) can be seen among the dense woody vegetation, whilst carnivores (leopard, African wild cat and African civet) use the dense vegetation as cover during hunting. Other species use the densely wooded areas as shelter (lion, common duiker).

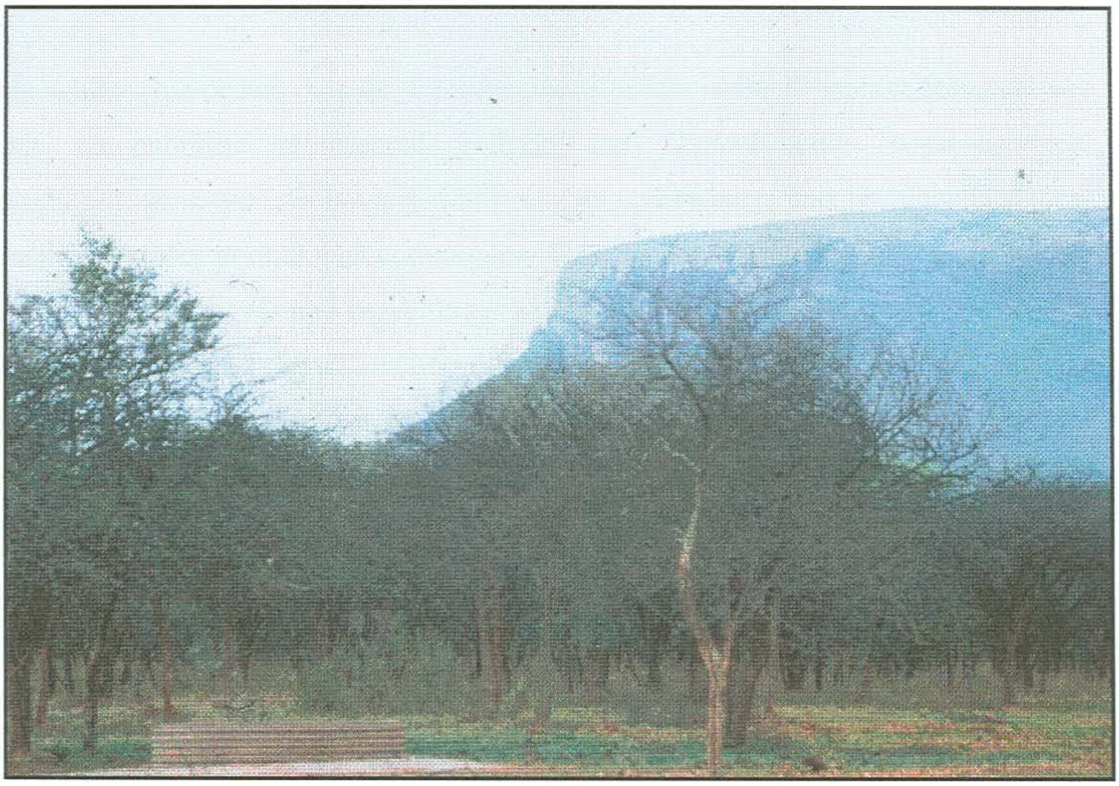

Figure 7.7 Typical black rhinoceros and elephant habitat within the Marakele National Park

5. Rocky Mountain Slopes Habitat Type

This habitat type occurs over large mountainous terrain in the Biosphere Reserve. The plant communities represented include the *Diplorhynchus condylocarpon-Englerophyton magalismontanum* warm slopes community, and the *Protea caffra-Loudetia simplex* cool slopes community. This habitat type is present on the rocky slopes of most reserves and game farms within the main Waterberg Mountain Range. Bothma (2000) notes that mountainous areas are separate management units, and the soils of the mountainous areas is of a sandy rubbly nature, very poor in nutrients and acidic (Acocks, 1988). The vegetation of these areas are thus mostly Sour Bushveld (Acocks, 1988), which supports selective grazing mammal species. The following species are diagnostic (SG 1, T. 7.1).

Procavia capensis (Rock Dassie)
Oreotragus oreotragus (Klipspringer)
Pelea capreolus (Grey Rhebuck)

The klipspringer and grey rhebuck are classified as being lower risk species dependent on conservation. The habitat of these species within conservation areas in the Biosphere Reserve is however well represented and therefore they are not under immediate threat. This habitat type also includes typical mountain grasslands (Bothma, 2000), and this area support low densities of species like the grey rhebuck, eland (*Taurotragus oryx)*, Mountain reedbuck (*Redunca fulvorufula*) and Jameson's red rock rabbit (*Pronolagus randensis*) (SG 5, T 7.1). This veld consists of short grasses (Bothma, 2000) and typical areas are represented in the High Altitude Mountain Ecozone (Chapter 5). Grazers mostly occur in these areas, although the highly selective browser, the klipspringer, and less selective browser, the kudu may occur in the shrubveld variation of the *Protea caffra-Loudetia simplex* plant community (Chapter 4).

The low lying, deciduous broadleaf plant communities of the rocky slopes in the Waterberg Biosphere Reserve (Coetzee *et al.* 1981), support similar species as the mountain grasslands, although overlapping habitats of the lowlands and slopes are more common. Certain species will graze or browse in the mountainous areas early in the season after veld fires, since the young grass growth is more palatable then. Species like buffalo (Fig. 7.8), eland, kudu and mountain reedbuck (SG 5, T 7.1) can be found in this habitat type, while species like Burchell's zebra and red hartebeest (SG 7, T. 7.1) do not prefer this habitat but will occasionally utilize it. When fruit and seeds are present on trees such as *Sclerocarya birrea, Pappea capensis, Englerophytum magalismontanum* and *Strychnos* species in this habitat type, chacma baboons and vervet monkeys will always be in the close vicinity.

Although larger mammal species may not be as common in this habitat type, smaller species such as the dassie and Jameson's red rock rabbit are important prey species to predators in this habitat type. Dassies are the main prey of leopard (SG 5, T 7.1) and black eagles in the rocky areas (Walker, 1986). The scavenger, the brown hyaena (SG 5, T 7.1), also seems to prefer these rocky areas to hide during the daytime, and these shy animals are more regularly sighted on game reserves in the Waterberg Biosphere Reserve when exposed to game drive vehicles and floodlights for long periods (Kilian, pers. comm.). Lion (SG 9, T 7.1) can be seen in this habitat type (if present on property), although it being more dependant on the availability of prey species (Skinner & Smithers, 1990). Other typical nocturnal animals which may be spotted by tourists in this habitat type include large spotted genet, small spotted genet and South African hedgehog (SG 5, T 7.1), and species with a wide habitat tolerance such as, African wild cat, porcupine, pangolin, honey badger and striped polecat (SG 9, T 7.1).

This habitat type is rugged and rocky and often difficult to access without fourwheel-drive vehicles. Although mammal species are not as common in these areas as in the grassland and savanna woodland habitat types, selective grazers and browsers do occur here. The area also provides plenty of shelter and mammals moving between lowlands and plateaus may be seen in this habitat type. Tourists must be prepared for a difficult and uncomfortable game drive when this habitat type is exploited within reserves. However, the spectacular scenery over the Waterberg and interesting variety of plant species increases makes this habitat type worthwhile to see for tourists.

Figure 7.8 Buffalo, spotted among *Protea caffra* representing the Rocky Mountain Slopes Habitat Type in the Entabeni Game Reserve

7.4 Conclusion

Game viewing is certainly one of the most popular tourist activities on game reserves in the Waterberg Biosphere Reserve. The incidence of a mammal species depend rather heavily on their food source availability and shelter (Delany, 1982), and therefore mammals will often move around in search of areas where their needs are optimally satisfied. However, although mammals are not absolutely restricted to specific habitat types, they still have certain preferences. Five different habitat types for the larger mammals within the Waterberg Biosphere Reserve were identified according to habitat preferences as follows:

- Open Water Habitat Type
- Grassland Habitat Type
- Savanna Woodland Habitat Type
- Dense Vegetation Habitat Type
- Rocky Mountain Slopes Habitat Type

These habitat types provide tourists and tourist guides the most likely localities where the mammals might be seen. Different mammal species might be seen in different habitat types comprised of different plant communities during different times of the day. Most herbivore species can be seen during the day during game drives, although night drives give tourists the opportunity to see shy nocturnal animals (e. g. aardvark, genets, bushbabies) and predators (e. g. leopard, brown hyaena, caracal). An aspect not included in this chapter is the seasonal variation in feeding periods of herbivores (Eltringham, 1997), which subsequently will also influence predator movements. Future research on this topic could provide further useful information in this regard to game reserves and parks hosting tourists in the Waterberg Biosphere Reserve.

Furthermore, the habitat types provide game farmers and reserve managers with useful information on which animals could be introduced on their property. However, most areas of the Waterberg Biosphere Reserve falls within the Sour Bushveld Veld Type (Acocks, 1988) and therefore the mammal species should be actively managed (game numbers, water, grazing capacity etc.) through a wildlife management plan.

This is even more important considering the species included in Appendix 7.2 listed as threatened in the IUCN red data list of South African mammals. Species like the critically endangered black rhinoceros, vulnerable cheetah and lion and endangered elephant and wild dog need monitoring programs and special conservation management strategies on their locations within the Waterberg Biosphere Reserve. However, the other species included as lower risk species in Appendix 7.2, dependent on conservation, are well represented within the conservation areas of the Waterberg and are not as threatened.

Table 7.1 Synoptic Table of the mammal habitat types within the Waterberg Biosphere Reserve

Habitat Type	Rocky slopes	Dense Vegetation	Savanna Woodland	Grassland	Open Water
Number of Plant Communities	2	3	3	3	1
Species Group 1					
Rock Dassie	100				
Klipspringer	100				
Grey Rhebuck	50				
Species Group 2					
Bushpig		100			
Nyala		100			
Bushbuck		100			
African Civet		66			
Species Group 3					
Gemsbok			100		
Wild dog			100		
Species Group 4					
Thick-tailed Bushbaby		100	33		
African Elephant		100	66		
Black Rhinoceros		100	33		
South African Lesser Bushbaby		33	100		
Banded Mongoose		66	66		
Common Duiker		66	66		
Species Group 5					
Large Spotted Genet	50	100	100		
Leopard	100	66	33		
Brown Hyaena	50	33	100		
Small Spotted Genet	50	33	100		
African Buffalo	50		66		
Kudu	50	33	33		
Tree Squirrel	50	66	100		
South African Hedgehog	50	33	100		
Eland	50		66		
Mountain Reedbuck	100		33		
Jameson's Red Rock Rabbit	100		33		
Chacma Baboon	50	66	33		
Vervet Monkey	50	100	66		

Species Group 6					
Cape Fox				66	
Cape Hare				33	
Blesbok				33	
Springbok				33	
Reedbuck				66	
Serval				66	
Species Group 7					
Springhare			33	100	
Caracal			100	66	
Roan			100	33	
Sable			100	66	
Scrub Hare			100	66	
Warthog			100	66	
Steenbok			66	66	
Tsessebe			66	100	
Cheetah			66	66	
Black Backed Jackal			66	66	
Blue Wildebeest			66	66	
Spotted Hyaena			66	33	
Burchell's Zebra			66	66	
Impala			100	33	
White Rhinoceros			100	66	
Red Hartebeest			100	100	
Species Group 8					
Bat-eared Fox		33		33	
Aardvark		33	66	66	
Side-Striped Jackal		33	66	33	
Waterbuck		33	66	66	
Aardwolf		33	33	100	
Giraffe		33	100	33	
Dwarf Mongoose		33	100	33	
Species Group 9					
African Wild Cat	100	100	100	66	
Porcupine	50	66	100	66	
Pangolin	50	33	100	33	
Lion	100	66	100	33	
Honey Badger	100	100	100	100	
Striped Polecat	100	66	100	100	
Species Group 10					
Hippopotamus					100
Cape Clawless Otter				33	100

Table 7.2 Classification of the larger mammal species within the Waterberg Biosphere Reserve (Plant Community numbers as described in Chapter 4)

Plant communities	4	5	3	9	10	6	7	11	1	8	12	2
Species Group 1												
Rock Dassie	1	1										
Klipspringer	1	1										
Grey Rhebuck	1											
Species Group 2												
Bushpig			1	1	1							
Nyala			1	1	1							
Bushbuck			1	1	1							
African Civet			1	1								
Species Group 3												
Gemsbok						1	1	1				
Wild dog						1	1	1				
Species Group 4												
Thick-tailed Bushbaby			1	1	1			1				
African Elephant			1	1	1	1		1				
Black Rhinoceros			1	1	1			1				
South African Lesser Bushbaby				1		1	1	1				
Banded Mongoose				1	1	1	1					
Common Duiker				1	1	1		1				
Species Group 5												
Large Spotted Genet		1	1	1	1	1	1	1				
Leopard	1	1	1	1		1						
Brown Hyaena		1			1	1	1	1				
Small Spotted Genet		1		1		1	1	1				
African Buffalo		1				1		1				
Kudu		1		1		1						
Tree Squirrel		1		1	1	1	1	1				
South African Hedgehog		1			1	1	1	1				
Eland	1					1		1				
Mountain Reedbuck	1	1				1						
Jameson's Red Rock Rabbit	1	1				1						
Chacma Baboon		1	1	1		1						
Vervet Monkey		1	1	1	1	1		1				

Species Group 6												
Cape Fox										1	1	
Cape Hare										1		
Blesbok										1		
Springbok										1		
Reedbuck									1		1	
Serval									1		1	
Species Group 7												
Springhare							1		1	1	1	
Caracal						1	1	1	1		1	
Roan						1	1	1			1	
Sable						1	1	1		1	1	
Scrub Hare						1	1	1		1	1	
Warthog						1	1	1		1	1	
Steenbok						1	1			1	1	
Tsessebe							1	1	1	1	1	
Cheetah							1	1		1	1	
Black Backed Jackal							1	1		1	1	
Blue Wildebeest							1	1		1	1	
Spotted Hyaena							1	1		1		
Burchell's Zebra							1	1		1	1	
Impala						1	1	1		1		
White Rhinoceros						1	1	1		1	1	
Red Hartebeest						1	1	1	1	1	1	
Species Group 8												
Bat-eared Fox					1					1		
Aardvark					1		1	1		1	1	
Side-Striped Jackal					1	1		1			1	
Waterbuck				1	1		1	1	1		1	
Aardwolf					1		1		1	1	1	
Giraffe				1		1	1	1			1	
Dwarf Mongoose					1	1	1	1		1		
Species Group 9												
African Wild Cat	1	1	1	1	1	1	1	1	1		1	
Porcupine		1	1	1		1	1	1		1	1	
Pangolin		1			1	1	1	1			1	
Lion	1	1		1	1	1	1	1		1		
Honey Badger	1	1	1	1	1	1	1	1	1	1	1	
Striped Polecat	1	1		1	1	1	1	1	1	1	1	
Species Group 10												
Hippopotamus												1
Cape Clawless Otter									1			1

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Appendix 7.1 Larger mammals of the Waterberg Biosphere Reserve and their habitat preferences according to two references

GENUS	SPECIES	Common name	Habitat Preferences (Skinner & Smithers, 1990)	Habitat Preferences (Mills & Hes, 1997)
ACINONYX	JUBATUS	Cheetah	Savanna woodland; open plains	Open plains, savanna woodland
AEPYCEROS	MELAMPUS	Impala	Open woodland, ecotone of grassland and woodland	Woodlands with shrubs, flat and gently undulating areas
ALCELAPHUS	BUSELAPHUS	Red hartebeest	Open grassland, vleis, open woodland	Open woodland, grassland, arid
ANTIDORCAS	MARSUPIALIS	Springbok	Open arid grassland	Short grass savanna
AONYX	CAPENSIS	Cape clawless otter	Aquatic, water areas with sufficient cover around; woodland, forest, grassland	Freshwater
ATELERIX	FRONTALIS	South African hedgehog	Any habitat with dry cover, not forests	Avoid mesic habitats, Acacia woodland
CANIS	ADUSTUS	Side-striped jackal	Closed savanna woodland, water closeby	Well watered broadleave savanna
CANIS	MESOMELAS	Black-backed jackal	Open savanna woodland and grassland	Open terrain
CARACAL	CARACAL	Caracal	Open savanna woodland, associated with open vleis and grassland	Open areas (vleis, wooded savanna, rocky areas
CERATOTHERIUM	SIMUM	White rhinoceros	Open savanna woodland, grasslands, water essential(mud)	Open savanna bushveld
CHLOROCEBUS	MITIS	Vervet monkey	Riparia savanna vegetation, rivierine woodland	Forest edges, sufficient tree woodlands
CIVETTICTIS	CIVETTA	African civet	Forest, thicket along permanent water	Woodland and riverine
CONNOCHAETES	TAURINUS	Blue wildebeest	Savanna woodland, water and shade essential	Short grass plains in savannas
CROCUTA	CROCUTA	Spotted hyaena	Open woodland and plains	Open plains and savannas
DAMALISCUS	LUNATUS	Tsessebe	Floodplains, areas close to open surface water, open woodland	Lightly wooded savannas, not arid
DAMALISCUS	PYRGARGUS PHILLIPSI	Blesbok	Grasslands with water available	Open grassland with water
DICEROS	BICORNIS MINOR	Black rhinoceros	Closed savanna woodland, thicket (tamboti), forest margins,ridges, encroached areas	Riverine and drainage line thicket, termitaria
EQUUS	BURCHELLI	Burchell's zebra	Open woodland, grassland (plains), water essential	Open plains, savanna woodland and grasslands
FELIS	LYBICA	African wild cat	Rocky hillsides, riverine underbrush, reedbeds, tall grass, kloofs, termitaria	Wide range, not arid
GALAGO	MOHOLI	South African lesser bushbaby	Savanna woodland, Acacia woodland; mixed Acacia associations	Open woodland
GENETTA	GENETTA	Small-spotted genet	Open savanna woodland, dry grasslands or vleis -arid areas	Woodland and riverine, dry areas
GENETTA	TIGRINA	Large-spotted genet	Riverine areas, savanna woodland	Closed woodland with water, forest
GIRAFFA	CAMELOPARDALIS	Giraffe	Open savanna woodland and scrub, Acacia species nb	Acacia savanna, open woodland
HELOGALE	PARVULA	Dwarf mongoose	Dry open woodland and grassland, termitaria	Open woodland, termitaria
HETEROHYRAX	BRUCEI	Yellow-spotted rock dassie	Rocky terrain, hills and outcrops	Rocky outcrops
HIPPOPOTAMUS	AMPHIBIUS	Hippopotamus	Open water with sandy banks	Open water, nearby grasslands
HIPPOTRAGUS	EQUINUS	Roan	Open savanna woodland with tall grass, water essential	Medium to tall grass in open savanna
HIPPOTRAGUS	NIGER	Sable	Open woodland with adjacent vleis or tall grassland, water	Open savanna bushveld, medium height grass

			essential	with moist vleis
HYSTRIX	AFRICAEAUSTRALIS	Porcupine	Rocky terrain, hills and outcrops, savanna woodland	Forests, woodland, savannas, grasslands
ICTONYX	STRIATUS	Striped polecat	Open grassland, savanna woodland and forest	Allhabitats except forest
KOBUS	ELLIPSIPRYMNUS	Waterbuck	Water associated areas, floodplains, open woodland	Dense, woody vegetation near water, open water, floodplains
LEPTAILURUS	SERVAL	Serval	Permanent water, tall grass, underbus and reedbeds	Moist tall grasslands
LEPUS	CAPENSIS	cape hare	Grassland, open arid country	Open arid terrain, short open grassland
LEPUS	SAXATILIS	Scrub hare	Savanna woodland, scrub	Scrub, tall grassland and savanna
LOXODONTA	AFRICANA	African elephant	Riverine valleys, woodland, forests, water essential	Savanna and woodland, forests
LYCAON	PICTUS	Wild dog	Open plains and savanna woodland	Savanna woodlands, broken hilly terrain
MANIS	TEMMINCKII	Pangolin	Savanna woodland with scrub, rocky hills, sandveld	Savanna woodlands, floodplains, rocky slopes, sandveld, termitaria
MELLIVORA	CAPENSIS	Honey badger	Any habitat	All habitats
MUNGOS	MUNGO	Banded mongoose	Closed savanna woodland, underbush, termitaria, thicket	Woodland and open savanna, termitaria
OREOTRAGUS	OREOTRAGUS	Klipspringer	Rocky habitat, mountainous	Rocky outcrops, slopes
ORYCTEROPUS	AFER	Aardvark	Open woodland, scrub and grassland (sandy), termitaria, not rocky	Open disturbed grassland, sandveld, floodplains
ORYX	GAZELLA	Gemsbok	Open grassland, bush savanna and woodland, arid	Arid open grasslands, rocky areas also
OTOCYON	MEGALOTIS	Bat-eared fox	Short open grassland with termitaria, open woodland with scant undercover	Short grassland with scattered shrubs
OTOLEMUR	CRASSICAUDATUS	Thick-tailed bushbaby	Forests, thicket and closed savanna woodland	Open woodland savanna, prefer riverine thicket
PANTHERA	LEO	Lion	Any habitat except forest	Not forests and arid extremes
PANTHERA	PARDUS	Leopard	Rocky koppies, hills, mountain ranges and forest	Mountains, rocky, bushveld, woodlands
PAPIO	URSINUS	Chacma baboon	Mountainous terrain, riverine woodland, forests	Cliffs, high trees
PARAHYAENA	BRUNNEA	Brown hyaena	Open woodland savanna, rocky mountainoius areas with bush cover	Open woodland
PARAXERUS	CEPAPI	Tree squirrel	Savanna woodland	Savanna woodland
PEDETES	CAPENSIS	Springhaas	Sandy soils, grasslands, vleis, floodplains	Short grassland, open vegetation, sandy soils, floodplains
PELEA	CAPREOLUS	Grey rhebok	Rocky hills, mountain slopes and mountain plateaus with grassland	Hills, mountains, slopes and plateaus, no rocks
PHACOCHOERUS	AFRICANUS	Warthog	Open woodland, scrub, grassland, floodplains around waterholes	Savanna and open woodlands
POTAMOCHOERUS	LARVATUS	Bushpig	Forest, thicket, riparian undercover, tall grassland, water essential	Forests and riverine
PROCAVIA	CAPENSIS	Rock dassie	Rocky terrain, hills and outcrops	Rocky outcrops with forage
PRONOLAGUS	RANDENSIS	Jameson's red rock rabbit	Rocky koppies, escarpment, rocky kloofs and gorges, boulder strewn hillsides	Rocky mountainous escarpment
PROTELES	CRISTATUS	Aardwolf	Open grassland and open savanna, vleis, termitaria	Open grassland, scrub

RAPHICERUS	CAMPESTRIS	Steenbok	Open grassland and open woodland	Open areas, tall grass with bushclumps
REDUNCA	ARUNDINUM	Reedbuck	Tall grassland, reedbeds, vleis,	Moist grassland
REDUNCA	FULVORUFULA	Mountain reedbuck	Dry grasslands on stony mountain lower slopes, open mountain grassland	Grassy mountain slopes with bushclumps
SYLVICAPRA	GRIMMIA	Common duiker	Closed woodland with underbush	Savanna woodland, shrubby grassland
SYNCERUS	CAFFER	African buffalo	Savanna woodland, water, grass and shade essential	Open woodland, grass and water
TRAGELAPHUS	ORYX	Eland	Open savanna woodland, scrub	Mountain grassland, moist savannas
TRAGELAPHUS	ANGASSI	Nyala	Closed woodland savanna, thicket, riverine woodland, forest	Dense woodland, thicket
TRAGELAPHUS	SCRIPTUS	Bushbuck	Riverine, underbush, water essential	Forest, closed woodland, riverine woodland
TRAGELAPHUS	STREPSICEROS	Kudu	Savanna woodland, rocky terrain with water, riverine woodland (thicket)	rocky hills, woodland
VULPES	CHAMA	Cape fox	Open grassland, grassland with scattered thicket	Open grassland, scattered thicket

Appendix 7.2 Conservation Status of mammal species in South Africa as classified by Hilton-Taylor (2000) in the Red data species list of the IUCN

Common name	Status
Cheetah	Vulnerable
Impala	Lower Risk (cd)
Red hartebeest	Lower Risk (cd)
Springbok	Lower Risk (cd)
Cape clawless otter	Common
South African hedgehog	Common
Side-striped jackal	Common
Black-backed jackal	Common
White rhinoceros	Lower Risk (cd)
Vervet monkey	Common
African civet	Common
Blue wildebeest	Lower Risk (cd)
Spotted hyaena	Lower Risk (cd)
Tsessebe	Lower Risk (cd)
Blesbok	Lower Risk (cd)
Black rhinoceros	Critically Endangered
Burchell's zebra	Common
Caracal	Common
African wild cat	Common
Serval	Common
South African lesser bushbaby	Common
Small-spotted genet	Common
Large-spotted genet	Common
Giraffe	Lower Risk (cd)
Dwarf mongoose	Common
Yellow-spotted rock dassie	Common
Hippopotamus	Common
Roan	Common
Sable	Lower Risk (cd)
Brown hyaena	Lower Risk (cd)
Porcupine	Common
Striped polecat	Common
Waterbuck	Lower Risk (cd)
cape hare	Common
Scrub hare	Common
African elephant	Endangered
Wild dog	Endangered
Pangolin	Lower Risk (cd)
Honey badger	Common
Banded mongoose	Common
Klipspringer	Lower Risk (cd)
Aardvark	Common
Gemsbok	Lower Risk (cd)
Bat-eared fox	Common
Thick-tailed bushbaby	Common

Lion	Vulnerable
Leopard	Common
Chacma baboon	Common
Tree squirrel	Common
Springhaas	Common
Grey rhebok	Lower Risk (cd)
Warthog	Common
Bushpig	Common
Rock dassie	Common
Jameson's red rock rabbit	Common
Aardwolf	Common
Steenbok	Common
Reedbuck	Lower Risk (cd)
Mountain reedbuck	Lower Risk (cd)
Common duiker	Common
African buffalo	Lower Risk (cd)
Eland	Lower Risk (cd)
Nyala	Lower Risk (cd)
Bushbuck	Common
Kudu	Common
Cape fox	Common

Appendix 7.3 Conservation status descriptions as classified in the IUCN red data list of threatened animals (Hilton-Taylor, 2000)

Critically Endangered:

A Taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.

Endangered:

A Taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

Vulnerable (Vu):

A Taxon is Vulnerable when it is not Critically Endangered or Endagered but is facing a very high risk of extinction in the wild in the medium-term future.

Lower Risk (LR):

A Taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable. Taxa in the Lower Risk category can be separayted into three subcategories:

1. Conservation dependent (cd). Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation program targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years
2. Near Threatened (nt). Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable
3. Least Concern (lc). Taxa which do no qualify for Conservation Dependent or Near Threatened

CHAPTER 8

BIRDS OF THE WATERBERG BIOSPHERE RESERVE AND THEIR HABITAT TYPES

8.1 Introduction

In the past few years birdwatching or "birding" as it is commonly referred to, has become one of the fastest developing pastimes throughout the western world (Sinclair, 1990). Fennel & Weaver (1997) noted that birds were the most important category of wildlife viewing in Canada, while preferences of tourists visiting three South African Nature Reserves in Kwazulu Natal also showed birdwatching to be a high priority ecotourist attraction.

In the area that comprises the ornithological region of southern Africa, nearly 900 species of birds are known to occur (Sinclair, 1990). Of these 108 species are included by Brooke (1984) in the red data list of southern African birds. Newman (1994) noted that each bird species has its habitat preference and utilizes a specialized niche in this habitat. The destruction or damage of the habitats might cause several bird species to disappear since they cannot adapt to their new, changed environment. The conservation of these habitat types to conserve the rare and endemic bird species therefore needs top priority in southern Africa.

Some of the most obvious patterns in bird communities are those relating species to habitats. Although, many studies have been done and models constructed to get a better understanding of bird-habitat relationships, the large array of factors (e. g. competition, habitat gradients, environmental factors, vegetation structure etc.) playing a role in determining a specific habitat of a bird species, are complex (Wiens, 1989) and were subsequently not included in the study. The TWINSPAN analysis was done to clearly identify specific bird communities associated to certain habitat types.

The aim of the chapter was therefore to identify and classify the habitat types of the more common and red data list birds (Hilton-Taylor, 2000) within the Waterberg Biosphere Reserve. Descriptions of the habitat types are done according to habitat preferences of bird species as described by Harrison *et al.* (1997). Different birds of importance to tourists and birdwatchers are emphasized in the descriptions, giving birders some information on species associated with specific habitat types. The importance of the conservation of certain sensitive habitats such as wetlands is also discussed.

8.2 Methods

8.2.1 Bird Database

A database of the birds occurring throughout the many diverse habitats within the Waterberg Biosphere Reserve was created. Data sets were obtained from the Avian Demography Unit and the data was collated from the South African Bird Atlas Project (Harrison, 1992; Harrison *et al.* 1997). Information consisted of avian distribution at a quarter degree grid cell (15' X 15' ~ 700 km^2). From the quarter degree lists, a single list of the birds occurring within the Biosphere Reserve was created. The list was edited in the following way. Birds described by Newman (1984) as being rare, yet not included in the Red Data list of Southern African Birds (Hilton-Taylor, 2000), were discarded, since the possibility for tourists of seeing these birds is minimal. However, the bird species with a high conservation priority (Hilton-Taylor, 2000) were included as important attractions for keen birders visiting the area.

The list with the individual conservation status of birds is included in Appendix 8.1. Appendix 7.2 in the previous chapter gives a description of the different meanings of the conservation status categories used by the IUCN in their red data list of threatened animal species (Hilton-Taylor, 2000). Migratory birds, only to be seen in the warmer summer months are marked with an asterisk. The list includes conspicuous and less conspicuous birds, since all tourists (from starters to keen birders) interested in birdwatching were included.

7.2.2 Habitat preferences of birds

Habitat preferences of birds occurring within the Waterberg Biosphere Reserve were obtained from Harrison *et al.* (1997). These preferences were included in Appendix 8.1. The habitat preferences were linked to the 12 major plant communities identified in the Waterberg Biosphere Reserve (Chapter 4) by comparing the description of the plant communities (Chapter 4) to the description by Harrison *et al.* (1997).

7.2.3 Habitat Classification and Identification

The identification of the major habitat types within which birds occur was done similar to the way mammal habitats were identified. A Two-Way-Species-Indicator-Analysis (TWINSPAN) (Hill, 1979) was done, using the following parameters for classification:

- ◊ Cutlevels for cover abundance: 0 - 2 - 10 - 25 - 50
- ◊ Maximum level of divisions: 3
- ◊ Other parameters were left default although the option to visualize the cluster hierarchy was selected

The classification produced 6 major habitat types, although the habitat type representing low-lying woodlands were given another level of division to separate the dense woodland and open woodlands (Edwards, 1983). The TWINSPAN classification was done using the plant communities similar to synrelevés in the classification of large vegetation datasets (Bredenkamp & Bezuidenhout, 1995). No abundance values were used, however, the presence of a bird species in a plant community was indicated as 1. The TWINSPAN classification revealed 7 different habitat types for birds within the Waterberg Biosphere Reserve, from which a classification table similar to a Braun-Blanquet table (Kent & Coker, 1996) for vegetation classification was created. From this table a synoptic table was created (Table 8.1) which show the diagnostic bird species for the habitat types and the habitat types within which bird communities occur.

The habitat types identified by TWINSPAN were described according to bird species composition (bird communities) and habitat characteristics (e. g. vegetation valuable for foraging / shelter / breeding within habitat).

7.3 Results and Discussion

7.3.1 Classification Hierarchy

The classification hierarchy of the different bird habitats of the bird occurring within the Waterberg Biosphere Reserve is presented in Figure 8.1 and is as follows:

- The first level of division for bird habitat types separates the birds inhabiting land as their dominant habitat type and the typical water-inhabiting mammals, similar to the mammals although the water-inhabiting birds do not live permanently in water.
- The water-inhabiting birds are divided on a second level into specialized birds occurring within the sponges of the Marakele National Park, and typical waterbirds associated with vleilands, pans and dams within the Waterberg Biosphere Reserve.
- The land-inhabiting birds are divided on a second level into birds occurring within the typical mountainous terrain of the Waterberg area, and birds occurring on the low-lying plains and bushveld woodlands.
- The bird species associated with the mountainous terrain are divided on a third level into typical evergreen afromontane forest-inhabiting birds living in kloofs and ravines, and bird species associated with rocky slopes and escarpments.
- The bird species of the low-lying areas are separated on a third level based primarily on differences in vegetation communities. The first group represents the grassland plains of the vertic clay floodplains (Nylsvley Nature Reserve) and old fields areas within the Waterberg Biosphere Reserve, while the second group represents all low-lying woodlands within the Waterberg Biosphere Reserve.
- Bird species associated with the low-lying woodlands were further divided on a fourth level into species associated with dense woodlands (e. g. termitaria, riverine vegetation along diabase / dolerite dykes) and species associated with open woodlands (deep sandy lowlands; terraces, foothills and plateaus; savanna plains)

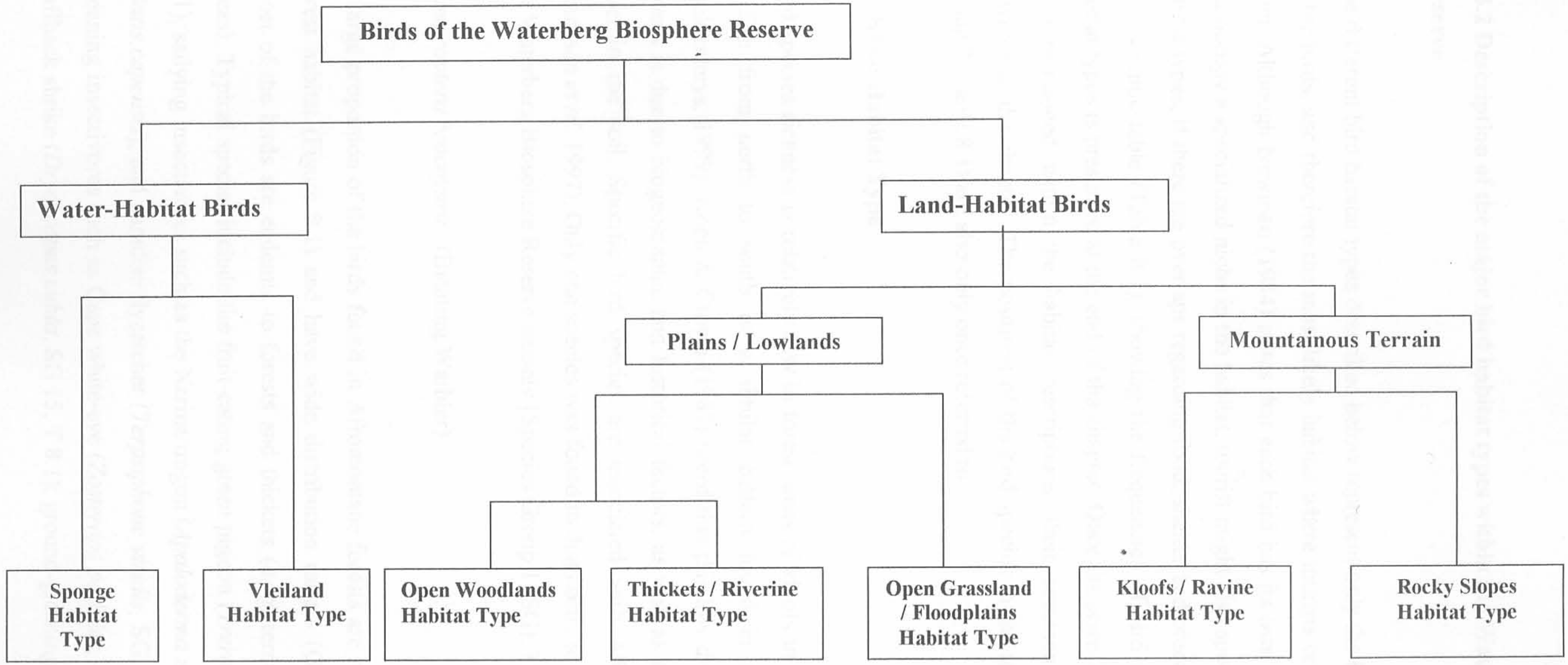

Figure 8.1 Dendrogram presenting TWINSPAN hierarchy of Waterberg Biosphere Reserve bird habitat types

7.3.2 Description of the major bird habitat types within the Waterberg Biosphere Reserve

The different bird habitat types described below represent only the habitat preferences of the birds, and therefore the most likely habitat where tourists or birders may view them. Although Newman (1984) states that each bird has its own habitat preference and occupy a specialized niche in the habitat, tourist might also spot the birds in other habitat types, if there are overlaps regarding food, shelter and breeding requirements. The synoptic table (Table 8.1), showing the frequencies of bird species within the habitat types is presented at the end of the chapter. Once the scientific names of birds were mentioned within the habitat descriptions, their common names are used onwards in the chapter. The positions of the bird species in the table (e. g. Species Group 2, Table 8.1) are also only once referred to.

1. Kloof Habitat Type

Bird species richness is relatively low in forest areas of kloofs in South Africa, and decline from north to south in a similar pattern found in the plant species (Geldenhuys, 1999). Koen & Crowe (1987) noted that this low diversity of birds in forests is due to biogeographic and historical factors, as well as the low nutritional level in the soil. Specific bird species are associated with Afromontane forests (Harrison *et al.* 1997). Only one species was found to diagnostic to kloof areas within the Waterberg Biosphere Reserve namely [Species Group 1 (SG), Table (T) 8.1):

Camaroptera brachyura (Bleating Warbler)

A large proportion of the birds found in Afromontane forests are not confined to the forest habitat (Figure 8.1) and have wide distribution ranges (Geldenhuys, 1999). Most of the birds are endemic to forests and thickets (e. g. termitaria, encroached areas). Typical species include the fruit-eating green pigeon (*Treron calva*, SG 10, T 8.1), sallying insectivores such as the Narina trogon (*Apaloderma narina*), Cape batis (*Batis capensis*), and paradise flycatcher (*Terpsiphone viridis*, SG 10, T 8.1); foliage gleaning insectivores such as Cape white-eye (*Zosterops pallidus*, SG 10, T 8.1) and puffback shrike (*Dryoscopus cubla*, SG 15, T 8.1); ground-gleaning insect-eaters such as the olive thrush (*Turdus olivaceus*) and the terrestrial bulbul (*Phyllastrephus terrestris*, SG 10, T. 8.1); ground-feeding seedeaters, for example the redeyed dove (*Streptopelia semitorquata*, SG 15, T 8.1); and nectar feeding species such as the malachite sunbird (*Nectarinia famosa*, SG 6, T 8.1). Some of the raptor species include the booted eagle (*Hieraaetus pennatus*, SG 6, T 8.1), gymnogene (*Polyboroides typus*), African Goshawk (*Accipiter tachiro*, SG 10, T 8.1) and Longcrested Eagle (*Lophaetus occipitalis*, SG 15, T 8.1).

Similarity in species composition of the Kloof Habitat Type and Dense Vegetation Habitat Type (SG 10, T 8.1) occur due to similar habitat requirements of birds (Harrison *et al.* 1997). The vegetation structure (closed canopy, figure 8.1) seems to play a major role in determining the bird communities of this habitat types, and Koen & Crowe (1987) concluded from a study in the Knysna Forest that floristics and vegetation structure, have a minor influence on bird community structure.

Forests are utilized heavily worldwide for their timber, and afforestation in Mpumalanga Province, South Africa is likely to contribute substantially to the potential extinction of many bird species, including several globally threatened species (Allan *et al.* 1996). Therefore the conservation of afromontane forests cannot be underestimated and its inclusion in any reserve network is necessary for the full representation of forest diversity (Eeley *et al.* 2001). The kloofs occurring within the Waterberg Biosphere Reserve have been well preserve until now and are presented in the Marakele National Park, Entabeni Game Reserve and several other areas along the escarpment.

The birds occurring within the kloof forests of the Waterberg Biosphere Reserve are rare, and mostly endemic to dense closed canopy vegetation. Birdwatchers can use this opportunity to view the birds in their natural habitat and the low diversity of bird species makes the identification easier, although the dense areas will hinder tourists from getting clear sights of birds.

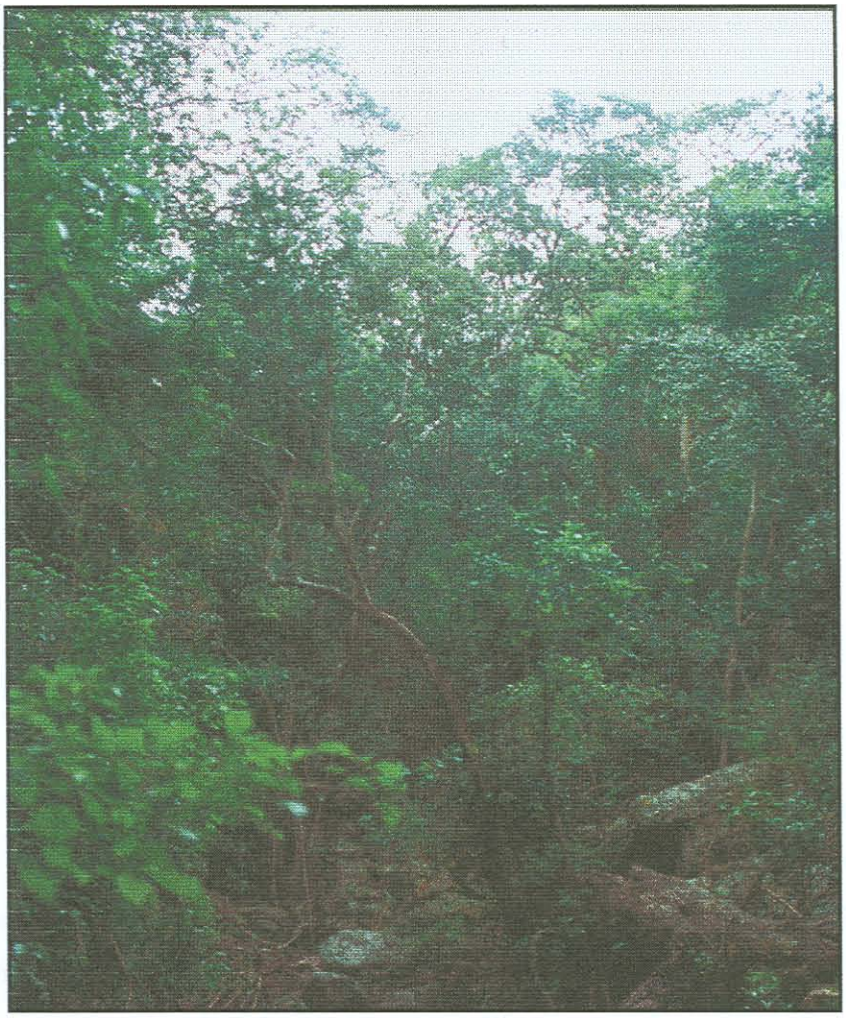

Figure 8.1 Typical kloof forest bird habitat in the Emaweni Game Lodge

2. Rocky Slopes Habitat Type

The typical rocky slopes and escarpment cliffs (figure 8.2) of the Waterberg area provide habitats to typical bird species associated with rocky habitats. Not many ornithologists have studied birds in mountainous areas of southern Africa. Two different major plant communities are represented in this habitat type namely the warm, rocky slopes (*Diplorhynchus-Englerophytum* community) and cool southern slopes and escarpment crest (*Protea caffra-Loudetia simplex* community). Diagnostic species of this habitat type include the following (SG 2, T 8.1):

Columba guinea	(Rock Pigeon)
Apus melba	(Alpine Swift)
Gyps coprotheres	(Cape Vulture)
Promerops gurneyi	(Gurney's Sugarbird)
Emberiza impetuani	(Larklike Bunting)

The cape vulture is the only vulture endemic to southern Africa and is listed in the red data list of southern African birds as being vulnerable (Hilton-Taylor, 2000). The largest colony (about 800 breeding pairs) in the world are found in the Marakele National Park (NPTB, 1999). Steyn (1982) noted that most large birds of prey are seriously threatened as a rule. However, species like the martial eagle (SG 13, T 8.1) and bateleur (SG 4, T 8.1) previously included in the red data list of birds (Brooke, 1984), have been discarded as threatened due to the many conservation areas available to the species in the savanna biome.

Typical birds preferring the high altitude mountainous grassland and escarpment areas to be viewed by tourists and birdwatchers include the following: Mountain chat (*Oenanthe monticola*), mocking chat (*Thamnolaea cinnamomeiventris*), rock martin (*Horundo fuligula*), redwinged starling (*Onychognathus morio*, SG 5, T 8.1), orangethroated longclaw (*Macronyx capensis*) and stonechat (*Saxicola torquata*, SG 19, T 8.1). The low-lying rocky mountainous terrain forms a mosaic with the woodlands of the lowlands and therefore many of the bird species occur in more than one habitat type. The bird species diversity on these ecotones between lowlands and rugged, rocky areas are subsequently high, making these areas highly suitable for birdwatching. The mountainous areas further provide an important food source (e. g.

hares, rock dassies, lizards) for raptor species such as black eagles (exclusive rock dassie feeder) (*Aquila verreauxii*), barn owls (*Tyto alba*, SG 5, T 8.1), booted eagle, spotted eagle owl (*Bubo africanus*) and African hawk eagle (*Hieraaetus spilogaster*, SG 14, T 8.1).

Although the bird diversity in this habitat type is not as high as other habitat types discussed in the following sections, several interesting endemic birds may be viewed by tourists or birdwatchers in these rocky areas. The many hiking trials meandering through the mountainous terrain within the Waterberg area brings tourists to unspoilt areas where these birds can be seen in their natural environment.

Figure 8.2 Typical cape vulture breeding area along the cliffs of the Kransberg Mountains in the Marakele National Park

3. Open Woodland Habitat Type

This habitat type is represented by three different plant communities and is the same as the Open Woodland Habitat Type for larger mammals as discussed in Chapter 7. The three different plant communities that provide habitats to bird species are the following: *Terminalia sericea-Eragrostis pallens* deep sand community, *Burkea africana-Setaria sphacelata* community of foothills, undulating plains and terraces, and the *Acacia nigrescens-Grewia flava* plains community (Chapter 4). More bird species can be seen in this habitat type than any other and the diversity is high. The more open terrain means that most of these bushveld birds are easier to observe than those inhabiting forests and marshes (Bredenkamp, 1999[b]). The following species are diagnostic to this habitat type (SG 4, T 8.1):

Milvus migrans migrans	(Black Kite*)
Milvus migrans parasitus	(Yellow billed Kite*)
Emberiza flaviventris	(Goldenbreasted Bunting)
Vidua paradisaea	(Paradise Whydah)
Amadina fasciata	(Cutthroat Finch)
Nilaus afer	(Brubru)
Batis molitor	(Chinspot Batis)
Muscicapa striata	(Spotted Flycatcher*)
Cisticola rufilata	(Tinkling Cisticola)
Sylvietta rufescens	(Longbilled Crombec)
Turdus litsitsirupa	(Groundscraper Thrush)
Mirafra rufocinnamomea	(Flappet Lark)
Indicator indicator	(Greater Honeyguide)
Tockus leucomelas	(Southern Yellowbilled Hornbill)
Lamprotornis nitens	(Glossy Starling)
Buphagus erythrorhynchus	(Redbilled Oxpecker)
Coracias naevia	(Purple Roller)
Caprimulgus rufigena	(Rufouscheeked Nightjar)
Otus senegalensis	(African Scops Owl)
Clamator jacobinus	(Jacobin Cuckoo*)
Eupodotis ruficrista	(Redcrested Korhaan)
Terathopius ecaudatus	(Bateleur)
Circeatus pectoralis	(Blackbreasted Snake Eagle)
Aquila nipalensis	(Steppe Eagle*)
Aquila rapax	(Tawny Eagle)
Thripias namaquus	(Bearded Woodpecker)
Gyps africanus	(Whitebacked Vulture)
Circaetus cinereus	(Brown Snake Eagle)
Torgos tracheliotus	(Lappetfaced Vulture)
Serinus atrogularis	(Blackthroated Canary)
Bubalornis niger	(Redbilled Buffalo Weaver)

The only bird species classified in the red list of South African birds is the lappetfaced vulture, a vulnerable species (Hilton-Taylor, 2000). Some of the typical savanna birds are specialists in terms of diet and habitat whilst other are generalists (Bredenkamp, 1999[b]). However, Harrison *et al.* (1997) noted that the avifauna of moist woodland (such as the Waterberg) as being a depauperate subset of that in Miombo Woodland. Although the avifauna of Miombo Woodlands seem to particularly species rich, several widespread woodland birds appear to avoid this vegetation type, e. g. redcrested korhaan, pearlspotted owl (*Glaucidium perlatum*) and violeteared waxbill (*Uraeginthus granatinus*) (SG 13, T 8.1). These species and several others seem to prefer drier woodlands occurring on the northern and eastern low-lying plains of the Biosphere Reserve (*Acacia nigrescens-Grewia flava* plains community, Chapter 4 in the Arid Sweet Low Mountains and Plains Ecozone and Mosaic Plains Ecozone, Chapter 5). The moist woodlands of the Waterberg Biosphere Reserve seem to have a lower diversity of birds, although most of the species will occur there in the drier season when food on the plains is scarce.

The open woodland habitat type supports many seedeaters such as doves, sparrows, weavers, waxbills, buntings and canaries. The majority of these find their food on the ground, however, the smaller seed-eaters may harvest seed whilst clinging to the grass stems. Fruit-bearing plants account for the presence of barbets species (e. g. blackcollared barbet, SG 12, T 8.1; pied barbet, SG 13, T 8.1) and grey louries (*Corythaixoides concolor*) (SG 13, T 8.1), which find most of their food in the canopies of trees and shrubs. Insectivores constitute a very large component of the avifauna, and there is an abundance of francolins, hoopoes, larks, hornbills, shrikes and robins, to name a few major groups that find their prey in every conceivable niche in this rich habitat. Shrikes, rollers (figure 8.4) and kingfishers hunt by swooping down from vantage point of trees to take their prey on the ground, while woodpeckers and woodhoopoes find their insect prey mainly on or under bark of tree trunks and thicker branches. Other bird groups foraging among the leaves and branches include shrikes, tits, warblers, white-eyes, batises, cuckoos, orioles and cuckoos. Some of the bee-eaters, flycatchers, and nightjars, as well as the forktailed drongo (*Dicrurus adsimilis*) (SG 15, T 8.1), "hawk" their prey from perches, while swifts, swallows and some raptors hunt "on the wing" (Bredenkamp, 1999[b]). Many colourful birds also occur in these groups discussed and are of particular interest to tourists visiting the area for the first time. Species like glossy starlings, yellowbilled hornbills (SG 4, T 8.1), Meyer's parrot (*Poicephalus meyeri*), crimsonbrested shrike (*Laniarius artococcineus*), lilacbreasted roller (*Coracias caudata*) (SG 13, T 8.1, figure 8.4) and blackheaded oriole (*Ardea melanocephala*) (SG 14, T 8.1) are quite conspicuous and may attract the attention of tourists interested in birds. Some of the species are however summer visitors (marked with *) and can only be seen during the warm summer months, such as the two kite species, spotted flycatcher, steppe eagle and Jacobin cuckoo.

However, the high diversity and populations of avifauna, as well as the presence of many small mammal species and reptiles make the presence of raptors and other birds of prey highly likely (figure 8.3). Species like yellowbilled kite, bateleur, booted eagle, giant eagle owl (*Bubo lacteus*) (SG 8, T 8.1) and martial eagle (*Polemaetus bellicosus*) (SG 13, T 8.1) are common when prey abound, while the availability of carrion will certainly cause vultures like the lappetfaced vulture and whitebacked vulture to be present (Bredenkamp, 1999[b]).

This habitat type has a huge potential for birdwatching as a tourist activity. Not only are the area an constant delight for experienced birders, but they are also arguably the first "hunting ground" of the budding birdwatcher (Bredenkamp, 1999[b]). The mostly open vegetation structure provides easy identification and walking through. Furthermore, the high diversity of bird groups that occur makes the identification quite a challenge and even more exciting to keen birdwatchers.

Figure 8.3 Raptor species like bateleurs (top) and tawny eagles (bottom) often use large dry trees as vantagepoints to rest and hunt from.

Figure 8.4 The beautiful lilacbreated roller is an insectivorous bird that occur throughout savanna woodlands in southern Africa

4. Dense Woodland Habitat Type

Many birds associated to this habitat type are also associated to similar dense vegetation like forests. However, specific bird species occur specifically in this habitat type which are represented by two major plant communities namely the *Dombeya rotundifolia-Panicum maximum* sweet rocky dykes and the *Acacia tortilis-Panicum maximum-Ziziphus mucronata* termitaria and encroached areas community (Chapter 4). The following species are diagnostic to this habitat type.

Eupodotis afra	Black Korhaan
Cypsiurus parvus	Palm Swift
Urocolius indicus	Redfaced Mousebird
Parisoma subcaeruleum	Titbabbler
Acrocephalus palustris	European Marsh Warbler*
Laniarius ferrugineus	Southern Boubou
Laniarius aethiopicus	Tropical Boubou
Tockus erythrorhynchus	Redbilled Hornbill
Podica senegalensis	African Finfoot
Colius colius	Whitebacked Mousebird
Sylvia borin	Garden Warbler*

The warbler species (European marsh warbler and garden warbler) are both summer visitors and occur along the riverine thickets associated with diabase and dolerite dykes as seen in figure 8.5. Although the diversity of species are not as high in this habitat type compared to the open woodland habitat type, several interesting species occur within it.

The termitaria thickets of this habitat type usually occur as the result of a bird's perch site such as an anthill or thorn tree. The birds drop the seeds, and shrubs and bushes grow up around the perch site (Lubke, 1999). As more and more species invade so the thicket bush clumps, as seen in the Nylsvley Nature Reserve and described by Coetzee *et al.* (1976). Dean *et al.* (1999) noted that large trees scattered through sparse grassy vegetation (such as the case of the termitaria thickets on the floodplains of the Nylsvley Nature Reserve) of arid savanna are focal points for bird activity because they supply nest sites, shade and food resources. The many fruit-bearing species occurring within termitaria bushclumps and riverine vegetation thicket such as *Pappea capensis* and several *Grewia* species provide food to frugivores such as mousebirds [e. g. speckled mousebird (*Collius striatus*), Grey hornbill (*Tockus* *nasutus)*, crested barbet (*Trachyphonus vaillantii*), (SG 8, T 8.1); blackeyed bulbul (*Pycnonotus barbatus*) and green pigeon (SG 10, T 8.1). The large trees further supply large birds such as owls (e. g. giant eagle owl; SG 8, T 8.1) and raptors [e. g. Wahlberg's eagle (*Aquila wahlbergi*), SG 13, T 8.1) with nesting-, roosting- and perch-hunitng sites (Maclean, 1970). Many waterbirds [e. g. hamerkop (*Scopus umbretta*), malachite kingfisher (*Alcedo cristata*), burchell's coucal (*Centropus burchellii*) and threebanded plover (*Charadrius tricollaris*), SG 24, T 8.1) also occur along the riverine vegetation associated with diabase and dolerite dykes, especially when streams have fresh flowing water. Other birds typical of encroached thickets include thrushes [e. g. kurrichane thrush (*Turdus libonyana*), SG 8, T 8.1; olive thrush (*Turdus olivaceus*) SG 10, T 8.1), the summer visitor flycatchers [e. g. bluegrey flycatcher (*Muscicapa caerulescens*), paradise flycatcher (*Terpsiphone viridis*), SG 10, T 8.1] and sunbirds [e. g. whitebellied sunbird (*Nectarinia talatala*), SG 8, T 8.1].

Although birders will find that watching birds in the thickets is easy in the lower canopy, the vegetation is often impenetrable and difficult to move in. Subsequently this habitat type is not very suitable for birdwatching, especially in the encroached areas on the eastern plains of the biosphere reserve. However, the termitaria vegetation and riverine areas are more suitable for birdwatching and a high diversity of birds, also from adjacent plant communities, may utilize the enriched soil bushclumps for nesting or feeding sites in the wetter summer months (Dean *et al.* 1999).

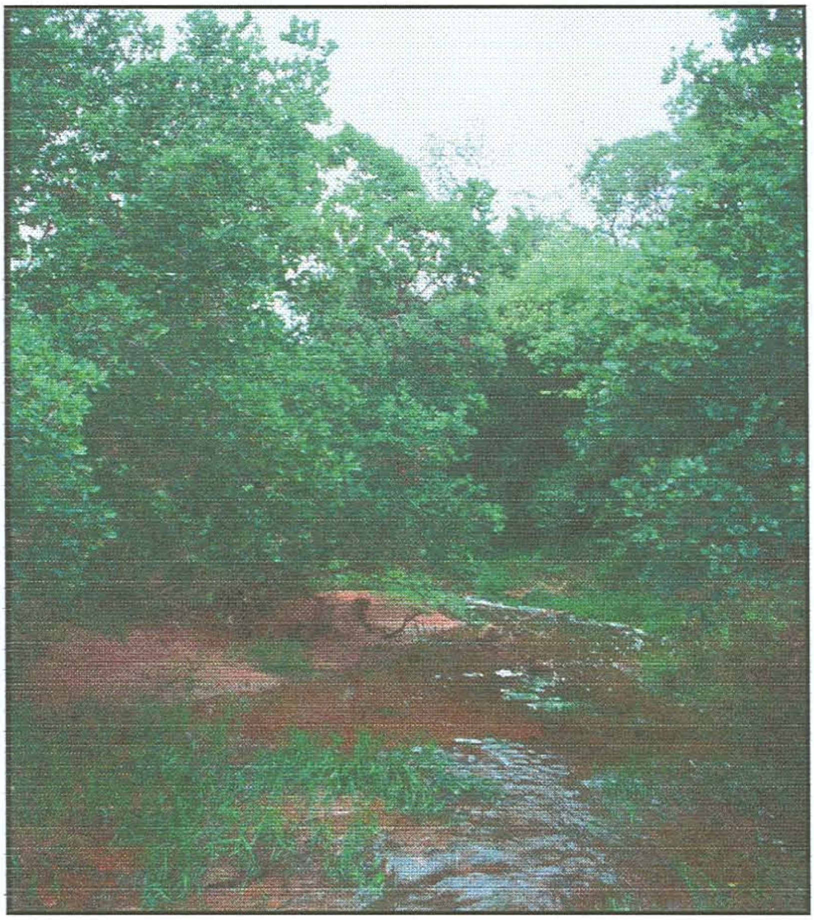

Figure 8.5 Many different bird species utilize the typical riverine vegetation along diabase or dolerite dykes as food source and cover

5. Grassland Habitat Type

The grassland habitat type is well represented on the many old fields (*Cynodon dactylon-Dichrostachys cinerea* old fields community) in the Waterberg, as well as on the floodplains in the Nylsvley Nature Reserve (*Setaria incrassata-Aristida bipartita* vertic clay community). The open grassland provides ideal nesting sites, food and shelter to many non-passerine birds. The following species was found diagnostic in this habitat type (SG 11, T 8.1):

Elanus caeruleus	Blackshouldered Kite
Falco naumanni	Lesser Kestrel*
Pterocles gutturalis	Yellowthroated Sandgrouse
Vidua funerea	Black Widowfinch
Estrilda erythronotos	Blackcheeked Waxbill
Vanellus coronatus	Crowned Plover
Calandrella cinerea	Redcapped Lark
Cisticola aridula	Desert Cisticola
Cisticola textrix	Cloud Cisticola
Motacilla capensis	Cape Wagtail
Erythropygia paena	Kalahari Robin

Most species occur throughout the year in the grassland habitat although the lesser kestrel is a summer visitor and classified as vulnerable by Hilton-Taylor (2000). The only other threatened southern African bird endemic to, but not restricted to the grassland biome, occurring in this habitat type is the blue crane (*Anthropoides paradisea*), South Africa's national bird, being classified as vulnerable (Hilton-Taylor, 2000). The importance to conserve these species in these wet (floodplains) and dry grasslands (old fields) in the Waterberg Biosphere Reserve cannot be underestimated, since these areas have been subjected to great ecological stress (Bredenkamp, 1999[a]).

The old fields and often overgrazed floodplains as disturbed habitats play an important role in increasing biodiversity of avifauna in the Biosphere Reserve. Natural ecological disturbance creates habitats that are used by a diverse group of birds. The disturbance and successional processes might play a direct role in structuring in structuring avian habitats and communities (Brawn *et al.* 2001). Maclean (1985) stated that old fields and the secondary growth that often springs up at the edges of disturbed ground are often utilized by many kinds of birds. Species like yellowthroated sandgrouse, crowned plover, spotted dikkop (*Burhinus capensis*)

(SG 13, T 8.1) and hadeda ibis (*Bostrychia hagedash*) and blue crane (SG 16, T 8.1) prefer the short open grassland encountered on the old fields, while the tall closed grasslands of the floodplains is preferred by a diverse group of seedeaters [blackcheeked waxbill, black widofinch, laughing dove (SG 13, T 8.1), grassveld pipit (*Anthus cinamomeus*) and longtailed widow (*Euplectus progne*, figure 8.6) (SG 16, T 8.1)], insect feeders [hoopoe (*Upupa epops*), european roller (*Coracias garrulus*) (SG 13, T 8.1) and little bee-eater (*Merops pusillus*) (SG 14, T 8.1)], waterbirds associated to the adjacent vleilands [water dikkop (*Burhinus vermiculatus*), blacksmith plover (*Vanellus armatus*), rare yellowbilled stork (*Myctera ibis*) ((SG 23, T 8.1) and rare summer visitor the white stork (*Ciconia ciconia*) (SG 25, T 8.1) and large specialized birds like the ostrich (*Struthio camelus*), the vulnerable (Brooke, 1984) kori bustard (*Ardeotis kori*) (SG 13, T 8.1) and secretary bird (*Sagittarius serpentarius*) (SG 14, T 8.1). The great variety of common birds and small mammals like shrews and mice provides food to many raptors and owls like the blackshouldered kite, pearlspotted owl (*Glaucidium perlatum*) (SG 13, T 8.1), longcrested eagle (SG 15, T 8.1) and marsh owl (*Asio capensis*) (SG 23, T 8.1).

Brawn *et al.* (2001) noted that the disturbed grasslands and floodplains of North America need conservation strategies involving the management of disturbance through some combination of flooding or fire application to potentially diversify avian habitats. The red data list birds like rare white stork and yellowbilled stork (Brooke, 1984) make the conservation of these areas (especially the floodplains in the Nylsvley Nature Reserve) important, strategies need to be implemented in the management plan of reserves where these habitats occur.

The potential of this habitat type as a birdwatching site holds great potential, since areas like floodplains form an ecotone between woodlands and wetlands, providing an added habitat to many bird species. Furthermore, the open areas on old fields make the viewing and identification of certain non-passerine species easy. People (tourists) starting to do birdwatching as a hobby might find this habitat type the best for quick and easy identification, since the diversity stretches from the largest ostrich to the smallest waxbill species.

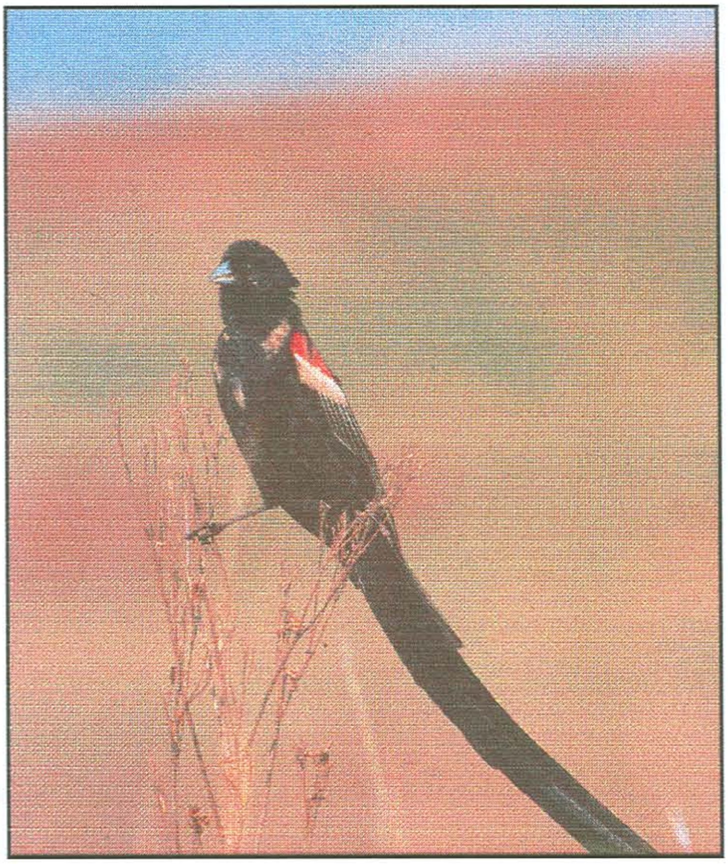

Figure 8.6 The longtailed widow is a common grassland biome bird that prefers tall grasslands like those on floodplains

6. Sponge Habitat Type

This is a very specialized wetland habitat type and occurs only in the high altitude mountainous areas of the Marakele National Park. The vegetation structure is the same as the floodplains area (tall closed grassland) in the Nylsvley Nature Reserve as classified by Van Staden (in prep.), although the species composition is different and shallow water is present for longer periods of the year compared to the seasonally flooded floodplains. No specific diagnostic bird species are found although many species are found communal to the grassland habitat type and vleiland habitat type (Species Groups 16, 22 and 23). Waterbirds preferring shallower water of marshes and floodplains are often encountered in this habitat type [African sedge warbler, cape shoveller (SG 22, T 8.1), great white egret (*Egretta alba*), moorhen (*Gallinula chloropus*), grey heron (*Ardea cinerea*) and woolynecked stork (*Ciconia episcopus*) (SG 23, T 8.1)]. However, other grassland birds like the golden bishop (*Euplectus afer*) and cape weaver (*Ploceus capensis*) (SG 23, T 8.1) also use the tall grass as nesting and feeding sites. The sponges further provide an important nesting site for the endemic blue crane and the conservation of these sites is therefore important. Morrison & Bothma (1998) also showed that wetland sites provide important nesting sites to crane species like the wattled and crowned cranes. The many red data list bird species (Appendix 8.1 and Table 8.1) occurring within this sensitive habitat type increase the importance of proper management strategies as emphasized by Van Staden (in prep.) for the sponges in the Marakele National Park.

Unfortunately for birdwatchers, the sponge habitat type is difficult to reach from the tourist road for easy bird identification and in future, bird hides could possibly be build closer to the sponges under strict conservation strategies. However, the sponges still remain one of the most sensitive plant communities (Chapter 4) in the Waterberg Biosphere Reserve and any tourist activities through the area should rather be guided by an experienced nature guide to prevent erosion and damage to the soil and vegetation. The many rare and interesting birds that may be seen in the sponges make this habitat type an absolute must for experienced birders, especially during the wet summer months.

7. Vleiland Habitat Type

This water-associated habitat type includes most aquatic bird species. The inland waters in the Waterberg Biosphere Reserve are highly varied in character, ranging from rivers, to lakes, pans, dams, marshes and vleis. The birdlife at these aquatic areas will vary according to size, the nature of its shoreline (steep, shelving, bare, dense vegetated etc.), the composition of its water (fresh, saline, brackish etc.) and whether or not it has emergent or floating vegetation (reeds, rushes, waterlilies etc.) (Maclean, 1985). Froneman *et al.* (2001) further concluded that structural diversity of vegetation in and around water ponds in the Western Cape, are especially important in determining their usage by waterbirds. The following species are diagnostic to this diverse, aquatic habitat type:

Ceryle rudis	Pied Kingfisher
Rynchops flavirostris	African Skimmer
Himantopus himantopus	Blackwinged Stilt
Recurvirostra avosetta	Avocet*
Microparra capensis	Lesser Jacana
Actophilornis africanus	African Jacana
Porphyrio porphyrio	Purple Gallinule
Oxyura maccoa	Maccoa Duck
Nettapus auritus	Pygmy Goose
Netta erythrophthalma	Southern Pochard
Anas capensis	Cape Teal
Alopochen aegyptiacus	Egyptian Goose
Dendrocygna viduata	Whitefaced Duck
Phoeniconaias minor	Lesser Flamingo*
Botaurus stellaris	Bittern*
Ixobrychus minutus	Little Bittern*
Anhinga melanogaster	Darter
Phalacrocorax africanus	Reed Cormorant
Phalacrocorax carbo	Whitebreasted Cormorant
Tachybaptus ruficollis	Dabchick

The lesser flamingo and African skimmer are classified as lower risk, near threatened species (Hilton-Taylor, 2000). Turpie (1995) emphasized the importance of prioritizing South African estuaries for the conservation of waterbirds. Species richness, conservation status, total numbers, and percentage of the regional population were considered the most important criteria for ranking wetlands in terms of their value to waterbirds. Wetland areas constitute some of the most threatened habitat in South Africa. The floodplains and Nile River ecosystem in the Nylsvley Nature

Reserve has been designated as a Ramsar Site and is of extraordinary importance for the maintenance of biological diversity. The area remains one of the most important South African breeding sites of common and rare waterbird species, especially in years of floods. The importance to create awareness among landowners in the Waterberg Biosphere Reserve of the importance of such wetlands should be a major conservation priority, and would ensure the conservation of smaller wetland areas in the Biosphere Reserve (Walmsley & Walmsley, 1999).

Typical of more open stretches of water are duck species [maccoa duck, cape teal, whitefaced duck (figure 8.8)], cormorants (reed cormorant, whitebreasted cormorant) and darter. Plovers [whitefronted plover (*Charadrius marginatus*) (SG 22, T 8.1), wattled plover (*Vanellus senegallus*) (SG 23, T 8.1)], sandpipers [curlew sandpiper (*Calidris ferruginea*), marsh sandpiper (*Tringa stagnatilis*) (SG 22, T 8.1), herons [Grey heron, purple heron (*Ardea purpurea*) (SG 23, T 8.1)] and loafing waterfowl (egyptian goose, pygmy goose) use bare shorelines. Reedbeds and marshes are the home of rails [African rail (*Rallus caerulescens*) (SG 23, T 8.1)], crakes [Baillon's crake (*Porzana pusilla*), black crake (SG 22, T 8.1)], moorhens, reed and marsh warblers [Cape reed warbler (*Acrocephalus gracilirostris*) (SG 22, T 8.1), African marsh warbler)] and some waxbills [common waxbill (*Estrilda astrild*) (SG 23, T 8.1)]. Floating vegetation usually supports jacanas and various crakes. Other birds like the beautiful African fish eagle (*Haliaeetus vocifer*) (SG 23, T 8.1) and kingfisher species [pied kingfisher, malachite kingfisher (SG 24, T 8.1, figure 8.7)] are dependent on the availability of fish and frogs for food (Harrison *et al.* 1997).

This bird group is excellent for the beginning birdwatcher, because many species are easy to identify. The habitat type is amongst the easiest to watch birds from the shorelines or even from a boat (Maclean, 1985). However, the high diversity of bird species also attracts the keen, experienced birders. Localities such as the Nylsvley Nature Reserve provide bird-hides to birdwatchers and this make the identification much easier. Other reserves in the Waterberg Biosphere Reserve could only benefit from constructing such hides along the many dams, rivers and wetlands in the Biosphere Reserve. However several of the waterbirds are summer visitors (indicated in Appendix 8.1) and the best time of year to see these birds are the wet summer months when they are most active.

Figure 8.7 Kingfisher species like the colourful malachite kingfisher, are easily identified and are popular among beginning birders

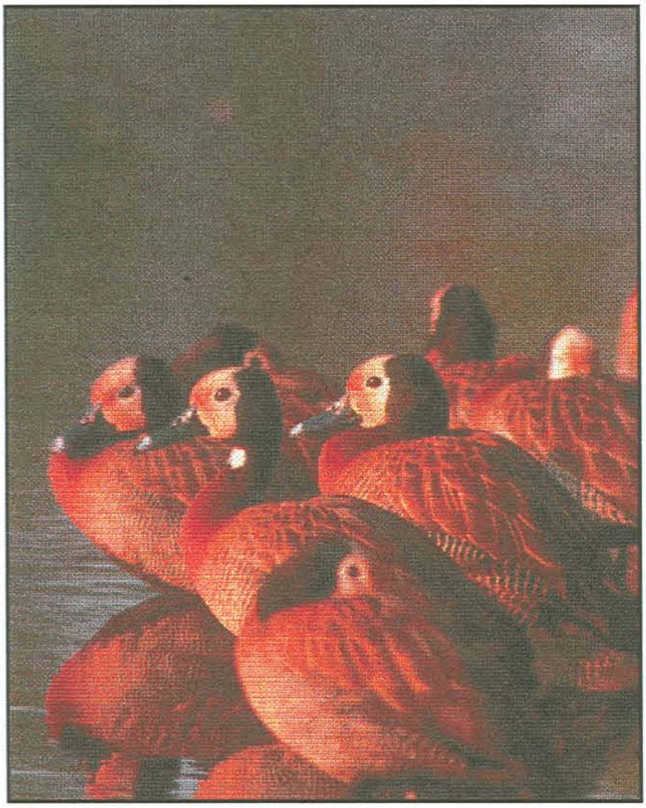

Figure 8.8 Duck species like whitefaced ducks prefer open water habitat associated with vleilands

8.4 Conclusion

Birdwatching is becoming more and more a popular ecotourist activity in South Africa, and the Waterberg area with its diverse landscapes and plant communities provides the ideal habitat to accommodate many different bird communities and individual species. Vegetation structure has been shown as one of the most important factors determining bird distribution patterns (Hauge, 1983), since vegetation type and structure reflect and integrate numerous climatic factors and non-climatic factors (e. g. latitude, altitude, topography, atmospheric circulation) (Harrison *et al.* 1997). The following 7 major habitat types were identified based on habitat preferences linked to the major plant communities (Chapter 4) in the Waterberg Biosphere Reserve:

- Kloof Habitat Type
- Rocky Slopes Habitat Type
- Open Woodland Habitat Type
- Dense Woodland Habitat Type
- Grassland Habitat Type
- Sponge Habitat Type
- Vleiland Habitat Type

From this study it becomes clear that birds utilize a far narrower habitat compared to mammal species, since certain plant communities like sponges, vleilands and kloofs were identified as specialized bird habitats. However, the diversity of birds in habitats like the open woodland habitat type varies from place to place according to climatic conditions and food source availability. For example, the arid woodlands on the eastern and northern plains of the Biosphere Reserve seem to have a higher diversity of birds than the lowland woodlands in the main Waterberg basin.

Tourists and birders can use the habitat types as references to identify and view most of the birds associated with them. Different bird species might be seen at different times of the day (e. g. nocturnal birds like owls and nightjars) and within different vegetation communities. Feeding and nesting sites often differ (Harrison *et al.* 1997) and therefore the bird species might be seen in other habitats, although the habitat types identified represent their preferences.

Of the total 383 bird chosen for the analysis, Hilton-Taylor (2000) listed only 6 in the red data list of South African birds. Of these 4 species, the blue crane, cape vulture, lappetfaced vulture and lesser kestrel were classified as vulnerable and 2 as lower risk species, namely the lesser flamingo and African skimmer. This emphasizes the important role the Waterberg Biosphere Reserve plays in the conservation of these threatened species. Reyers *et al.* (2002) showed the potential avifauna conservation areas of the Limpopo Province, by using data from the avifauna database of the Bird Atlas Project (Harrison, 1992). It was concluded that the inclusion of species assemblage structure as well as the underlying environmental gradients ensures a conservation area network that strives to maintain both biodiversity pattern and process. The representation of the different plant communities as bird habitat types in the Waterberg Biosphere Reserve plays an important role in the conservation of these diverse avifauna communities. Conservation strategies for certain sensitive habitat types like wetlands also need to be emphasized in future to prevent damage to the habitat of threatened bird species like saddlebilled stork and lesser jacana.

Smaller reserves occur throughout the Biosphere Reserve, and although they usually do not have the capacity to host the big game species, the potential for these reserves to promote birdwatching is huge. Not only can they provide tourists with bird checklists, the tourists can easily identify the birds by simply sitting in one place (at a bird hide or even at their chalet / camping site), taking a walking trial or a game drive with experienced birding guides. The potential for birdwatching in the Waterberg as a specialized activity still needs promotion, in the vast and unexplored areas of the Waterberg.

Table 8.1 Synoptic table of the habitat types of birds of theWaterberg Biosphere Reserve

Habitat Type	Kloofs	Rocky slopes	Open woodland	Dense woodland	Grassland	Sponges	Vleis
Number of Plant Communities	1	2	3	2	2	1	1
Species Group 1							
Bleating Warbler	100						
Species Group 2							
Rock Pigeon		100					
Alpine Swift		100					
Cape Vulture		100					
Gurney's Sugarbird		100					
Larklike Bunting		50					
Species Group 3							
Cape Robin	100	50					
Species Group 4							
Black Kite			100				
Yellowbilled Kite			100				
Goldenbreasted Bunting			100				
Paradise Whydah			100				
Cutthroat Finch			100				
Brubru			100				
Chinspot Batis			100				
Spotted Flycatcher			100				
Tinkling Cisticola			100				
Longbilled Crombec			100				
Groundscraper Thrush			100				
Flappet Lark			100				
Greater Honeyguide			100				
Southern Yellowbilled Hornbill			100				
Glossy Starling			100				
Redbilled Oxpecker			100				
Purple Roller			100				
Rufouscheeked Nightjar			100				
African Scops Owl			100				
Jacobin Cuckoo			100				
Redcrested Korhaan			100				
Bateleur			100				
Blackbreated Snake Eagle			100				
Steppe Eagle			100				
Tawny Eagle			100				
Bearded Woodpecker			67				
Whitebacked Vulture			67				
Brown Snake Eagle			33				
Lappetfaced Vulture			33				
Blackthroated Canary			33				
Redbilled Buffalo Weaver			33				

Species group 5				
Cape Bunting		50	100	
Rock Kestrel		100	100	
Little Banded Goshawk		100	100	
House Martin		100	67	
Barn Owl		100	67	
Black Eagle		100	33	
Rock Bunting		100	33	
Streakyheaded Canary		100	33	
Redwinged Starling		100	33	
Longbilled Pipit		100	33	
Mocking Chat		100	33	
Buffstreaked Chat		100	33	
Mountain Chat		100	33	
Whitenecked Raven		100	33	
Rock Martin		100	33	
Freckled Nightjar		100	33	
Lanner Falcon		100	33	
Jackal Buzzard		100	33	
Species Group 6				
Booted Eagle	100	100	100	
Cape Rock Thrush	100	100	67	
Malachite Sunbird	100	100	33	
Black Swift	100	100	33	
Species group 7				
Black Korhaan				100
Palm Swift				100
Redfaced Mousebird				100
Titbabbler'				100
European Marsh Warbler				100
Southern Boubou				100
Tropical Boubou				100
Redbilled Hornbill				100
African Finfoot				50
Whitebacked Mousebird				50
Garden Warbler				50
Species Group 8				
Speckled Mousebird			33	100
Kurrichane thrush			33	100
Arrowmarked Babbler			33	100
Greyhooded Kingfisher			33	100
Crested Francolin			33	100
Grey Hornbill			67	100
Whitebrowed Robin			100	100
Shafttailed Whydah			100	100
Whitebellied Sunbird			100	100
Blackcrowned Tchagra			100	100
Threestreaked Tchagra			100	100
Yellowbellied Eremomela			100	100
Crested Barbet			67	100
Swallowtailed Bee-eater			100	100
Whitefaced Owl			100	100

Barred Warbler			33	50	
Cape Penduline Tit			33	50	
Greenspotted Dove			33	50	
Icterine Warbler			33	50	
Spectacled Weaver			67	50	
Bennet's Woodpecker			67	50	
Greater Blue-eared Starling			67	50	
White Helmetshrike			100	50	
Yelloweyed Canary			100	50	
Scimitarbilled Woodhoopoe			100	50	
Woodland Kingfisher			100	50	
Giant Eagle Owl			100	50	
Species group 9					
Redheaded Weaver		50	67	50	
Grey Penduline Tit		50	67	50	
Southern Black Tit		50	67	50	
Yellowthroated Sparrow		100	67	50	
Black Sunbird		100	67	50	
Lazy Cisticola		100	33	50	
Familiar Chat		100	33	50	
Yellowfronted Tinker Barbet		100	67	50	
Lizzard Buzzard		100	67	50	
Species Group 10					
Cape White-Eye	100			100	
Cape Batis	100			100	
Bluegrey Flycatcher	100			100	
Yellowbellied Bulbul	100			100	
Terrestrial Bulbul	100			100	
Blackeyed Bulbul	100			100	
Pygmy Kingfisher	100			100	
Klaas's Cuckoo	100	100	33	100	
Redchested Cuckoo	100			100	
Green Pigeon	100			100	
Gymnogene	100			100	
African Goshawk	100			100	
Black Sparrowhawk	100			100	
Little Sparrowhawk	100			100	
Cuckoo Hawk	100			100	
Natal Francolin	100	100	67	100	
Striped Pipit	100	100	33	50	
Longtailed Wagtail	100			50	
Paradise Flycatcher	100		67	50	
Olive Thrush	100			50	
Narina Trogon	100			50	
Species Group 11					
Blackshouldered Kite					100
Lesser Kestrel					100
Yellowhtroated Sandgrouse					100
Black Widowfinch					50
Blackcheeked Waxbill					50
Crowned Plover					50
Redcapped Lark					50

Desert Cisticola			50
Cloud Cisticola			50
Cape Wagtail			50
Kalahari Robin			50
Species Group 12			
Blackcollared Barbet		50	50
Whitefronted Bee-eater		50	50
Black Flycatcher		50	50
Bronze Mannikin		50	50
Redheaded Finch		50	50
Species Group 13			
Redcollared Widow	33	50	100
Namaqua Dove	33	50	100
Whitebellied Korhaan	33		100
Pintailed Whydah	33		100
Fiscal Shrike	33		100
Bushveld Pipit	67	50	100
Rattling Cisticola	33	50	100
Black Crow	33	50	100
Martial Eagle	67		100
Ostrich	67		100
Violeteared Waxbill	100	50	100
Redbilled Quelea	100	100	100
Greybacked Finchlark	33		100
Chestnutbacked Finchlark	67		100
Sabota Lark	100	100	100
Diederik's Cuckoo	100	50	100
African Cuckoo	100	50	100
Meyer's Parrot	100	100	100
Laughing Dove	100		100
Helmeted Guineafowl	100		100
Marico Sunbird	33		50
Redbacked Shrike	33		50
Lesser Grey Shrike	33		50
European Bee-eater	33		50
Burchell's Sandgrouse	33		50
Pale Chanting Goshawk	33		50
Gabar Goshawk	33		50
Scalyfeathered Finch	33	50	50
Pied Babbler	33	50	50
Lilacbreasted Roller	33	50	50
Spottedbacked Weaver	33	50	50
Redeyed Bulbul	33	100	50
Fierynecked Nightjar	33	100	50
Whitecrowned Shrike	33		50
European Swift	33		50
Kori Bustard	33		50
Redbilled Firefinch	33	100	50
Lesser Masked Weaver	33		50
Ayres' Cisticola	33		50
Burntnecked Eremomela	67	100	50
Shorttoed Rock Thrush	67		50
Pied Barbet	67		50

Mozambique Nightjar		67	100	50
Bronzewinged Courser		67		50
Coqui Francolin		67	50	50
Steelblue Widowfinch		100	50	50
Purple Widowfinch		100		50
Whitebrowed Sparrowweaver		100		50
Burchell's Starling		100	100	50
Plumcoloured Starling		100		50
Greyheaded Bush Shrike		100		50
Orangebreasted Bush Shrike		67	100	50
Crimsonbreasted Shrike		100	50	50
Longtailed Shrike		100		50
Fairy Flycatcher		100	100	50
Fiscal Flycatcher		100		50
Marico Flycatcher		100	50	50
Blackchested Prinia		67	50	50
Whitethroated Robin		100	100	50
Ashy Tit		100	100	50
Fawncoloured Lark		100		50
Rufousnaped Lark		33	50	50
Monotonous Lark		100		50
Redthroated Wryneck		100		50
Cardinal Woodpecker		100	100	50
Goldentailed Woodpecker		100	100	50
Redbilled Woodhoopoe		100	100	50
Hoopoe		100	50	50
European Roller		100		50
Striped Kingfisher		100		50
European Nightjar		100		50
Pearlspotted Owl		100	50	50
Great Spotted Cuckoo		100	100	50
Black Cuckoo		100		50
Grey Lourie		100	100	50
Spotted Dikkop		67		50
Kurrichane Buttonquail		100		50
Ovambo Sparrowhawk		100	50	50
Wahlberg's Eagle		100	50	50

Species Group 14

Little Bee-eater	50	67		100
Pied Crow	100	100	100	100
Cape Turtle Dove	100	100	100	100
Stanley's Bustard	50	33		100
Secretarybird	100	100		100
Blackheaded Oriole	50	67	50	50
Black Cuckooshrike	50	100		50
Dark Chanting Goshawk	50	67	50	50
Yellow Canary	50	33		50
Greater Doublecollared Sunbird	100	100	50	50
Neddicky	100	33		50
South African Cliff Swallow	50	33		50
Clapper Lark	50			50
Spotted Eagle Owl	100	33		50
Doublebanded Sandgrouse	100	67		50
African Hawk Eagle	100	100		50

Species Group 15						
Swee Waxbill	100			100	100	
Lesser Honeyguide	100		100	100	50	
Willow Warbler	100	100	100	100	50	
Forktailed Drongo	100		100	50	50	
Bluebilled Firefinch	100			50	50	
Puffback	100	100	100	100	50	
Bartthroated Apalis	100	100	100	100	50	
Brownhooded Kingfisher	100		100	50	50	
Redeyed Dove	100		67	100	50	
Longcrested Eagle	100		100		50	
Species Group 16						
Orangebreasted Waxbill					100	100
Longtailed Widow					100	100
Whitewinged Widow					50	100
Red Bishop					100	100
Greyheaded Sparrow					100	100
Capped Wheatear					50	100
Pinkbilled Lark					100	100
Greyrumped Swallow					100	100
Grassveld Pipit					100	100
Cattle Egret					100	100
Abdim's Stork					100	100
Sacred Ibis					100	100
Hadeda Ibis					100	100
Blue Crane					100	100
Temminck's Courser					50	100
Grass Owl					50	100
Species Group 17						
Plainbacked Pipit				50	50	100
Species Group 18						
Greater Kestrel			67		50	100
Redbreasted Swallow			100		50	100
Great Reed Warbler			33	100	50	100
Grassbird			67		50	100
Eastern Redfooted Kestrel			33		100	100
Common Quail			33		100	100
Anteating Chat			33		100	100
Masked Weaver			33	50	100	100
Melba Finch			33	50	100	100
Jameson's Firefinch			67	50	100	100
Lesser Striped Swallow			100		100	100
Greater Striped Swallow			100		100	100
Swainson's Francolin			33		50	100
Cape Sparrow			33		50	100
Species Group 19						
Orangethroated Longclaw		50				100
Stonechat		50			50	100
Brownthroated Martin		50			50	100
Blue Waxbill		100	100	100	50	100

Carmine Bee-eater		50	100		100	100	
Little Swift		50			50	100	
Species Group 20							
Whiterumped Swift	100	100	100	100	100	100	
European Swallow	100	100	100	100	100	100	
Species Group 21							
Pied Kingfisher							100
African Skimmer							100
Blackwinged Stilt							100
Avocet							100
Lesser Jacana							100
African Jacana							100
Purple Gallinule							100
Maccoa Duck							100
Pygmy Goose							100
Souhtern Pochard							100
Cape Teal							100
Egyptian Goose							100
Whitefaced Duck							100
Lesser Flamingo							100
Bittern							100
Little Bittern							100
Darter							100
Reed Cormorant							100
Whitebreasted Cormorant							100
Dabchick							100
Species Group 22							
African Sedge Warbler						100	100
Cape reed Warbler						100	100
Whitewinged Tern						100	100
Greyheaded Gull						100	100
Curlew Sandpiper						100	100
Greenshank						100	100
Marsh Sandpiper						100	100
Whitefronted Plover						100	100
Baillon's Crake						100	100
Black Crake						100	100
Cape Shoveller						100	100
Little Egret						100	100
Species Group 23							
Great White Egret					50	100	100
Blackheaded Heron					100	100	100
Rufousbellied Heron					50	100	100
Dwarf Bittern					50	100	100
Blackcrowned Night Heron					50	100	100
Greenbacked Heron					50	100	100
Yellowbilled Egret					50	100	100
Marsh Owl					50	100	100
Water Dikkop					50	100	100
Ethiopian Snipe					50	100	100
Ruff					100	100	100

Little Stint				50	100	100
Wood Sandpiper				50	100	100
Common Sandpiper				50		100
Wattled Plover				50		100
Blacksmith Plover				50		100
African Fish Eagle				50		100
Yellowbilled Duck				50		100
Fulvous Duck				50		100
Saddlebilled Stork				50		100
Squacco Heron				50		100
Purple Heron				50		100
Kittlitz's Plover				100	100	100
Grey Plover				50	100	100
Redknobbed Coot				50	100	100
Moorhen				50	100	100
African Rail				50	100	100
African Marsh Harrier				50	100	100
Spurwinged Goose				50	100	100
Redbilled Teal				50	100	100
Hottentot Teal				50	100	100
African Spoonbill				50	100	100
Glossy Ibis				50	100	100
Yellowbilled Stork				50	100	100
Woolynecked Stork				50	100	100
Black Stork				50	100	100
Grey Heron				50	100	100
Levaillant's Cisticola				50	100	100
Redfaced Cisticola				50	100	100
Cuckoo Finch				50	100	100
Cape Weaver				100	100	100
Golden Bishop				50	100	100
Quail Finch				100	100	100
Common Waxbill				100	100	100
Fantailed Cisticola				50	100	100
Species Group 24						
Hamerkop			50			100
Whitebacked Night Heron			50			100
African Black Duck			50			100
Malachite Kingfisher			50			100
Giant Kingfisher			50			100
Burchell's Coucal			50	50		100
Threebanded Plover			50			100
African Marsh Warbler			100	50	100	100
Whitethroated Swallow			50	50	100	100
Species Group 25						
Steppe Buzzard		67	100	50		100
Marabou Stork		100		50		100
White Stork		67		100	100	100
Tawnyflanked Prinia		33	50	50	100	100
Species Group 26						
Pearlbreasted Swallow	100	100		50	100	100
African Pied Wagtail	100		50	50		100

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Appendix 8.1 Bird list of the Waterberg Biosphere Reserve showing the conservation status of birds, migratory birds (*) and habitat preferences

Species number	Species name	Common name	Status	Habitat preference
1	*Struthio camelus*	Ostrich	Common	Bushveld to desert
8	*Tachybaptus ruficollis*	Dabchick	Common	Dams, lakes, slow-flowing streams, rarely marine on West coast
55	*Phalacrocorax carbo*	Whitebreasted Cormorant	Common	Marine and inland waters, usually larger dams and pans
58	*Phalacrocorax africanus*	Reed Cormorant	Common	Inland waters of any size, down to tiny dams and ponds
60	*Anhinga melanogaster*	Darter	Common	Inland water, quiet lakes, pans and slow-flowing rivers. Occasional on estuaries and lagoons
62	*Ardea cinerea*	Grey Heron	Common	Bodies of shallow open water. Wetlands such as rivers, dams, marshes and estuaries. Intertidal rock pools. Tall trees for breeding and roosting, also in reedbeds and on cliffs.
63	*Ardea melanocephala*	Blackheaded Heron	Common	Open habitats, grasslands, pastures and fields of "stubble". Areas close to wetlands. Tall trees or reedbeds are required for breeding and roosting. Adapted to urbanisation.
65	*Ardea purpurea*	Purple Heron	Common	Dense emergent vegetation in shallow fresh or estuarine waters. Reed beds, marshes, reed-fringed rivers and lakes and flooded areas with tall grass and sedges.
66	*Egretta alba*	Great White Egret	Common	Shallow open waters at lakes, rivers, floodplains, flooded grasslands, marshes, saltpans and estuaries. Also artificial wetlands (e.g. dams and sewerage works)
67	*Egretta garzetta*	Little Egret	Common	Open areas of shallow water, margins of lakes, dams, rivers, marshes, irrigated land and sewerage works. Also saltpans, estuaries and mangrove swamps along open coastline, especially rocky shores.
68	*Egretta intermedia*	Yellowbilled Egret	Common	Suitable bodies of shallow water or wet grasslands. Avoids mountainous regions, forest and desert. Favours the margins of lakes, rivers, saltpans and estuaries, especially seasonal waterbodies, marshes and flooded grasslands with short emergent vegetation
71	*Bubulcus ibis*	Cattle Egret	Common	Open short grasslands, pastures and cultivated fields. Usually in flocks accompanying cattle or large game. Requires water for drinking. Roosts on the shorelines of inland waters and in trees. Nests in trees and reedbeds.
72	*Ardeoal ralloides*	Squacco Heron	Common	Freshwater habitats, preferring emergent vegetation in the quiet backwaters of ponds and the edges of slow flowing rivers and streams. Adequate reed

				cover and bushes and trees are prerequisites.
74	*Butorides striatus*	Greenbacked Heron	Common	Variety of aquatic habitats, both fresh and salt water. Densely vegetated rivers, streams, estuaries, lakes, ponds, swamps and mangroves. Occasionally in open waters and floodplains.
75	*Butorides rufiventris*	Rufousbellied Heron*	Common	It occurs in tropical and subtropical rivers well vegetated with aquatic grasses, sedges, papyrus and reeds, also floodplains, pans and coastal lakes in woodland regions. Occasional found at dams and sewerage works.
76	*Nycticorax nycticorax*	Blackcrowned Night Heron*	Common	Dense vegetation along the edges of shallow, still or slow moving water such as lakes, pans, rivers, marshes or seasonal floodplains and estuaries.
77	*Gorsachius leuconotus*	Whitebacked Night Heron	Common	Tree-lined rivers and streams, mangroves, less commonly in reedbeds along rivers and in marshes
78	*Ixobrychus minutus*	Little Bittern*	Common	Reedbeds in standing water (Typha and Phragmites)
79	*Ixobrychus sturmii*	Dwarf Bittern*	Common	Seasonal freshwater wetlands (pans, floodplains and pools) with dense overhanging foliage along the margins. Reed marshes and mangroves.
80	*Botaurus stellaris*	Bittern*	Common	Tall, dense emergent vegetation (reed beds and sedge) at large wetlands.
81	*Scopus umbretta*	Hamerkop	Common	Most inland waters, occasional on seashore
83	*Ciconia ciconia*	White Stork*	Common	Open woodland, grassland, grassy Karoo and wetland areas, also agricultural fields and pastures.
84	*Ciconia nigra*	Black Stork	Common	Shallow water (and occasionally dryland) in streams and rivers, marshes, floodplains, coastal estuaries, large and small dams.
85	*Ciconia abdimii*	Abdim's Stork*	Common	Most commonly found in grassland, pastures and cultivated fields.
86	*Ciconia episcopus*	Woollynecked Stork*	Common	Around wetlands, such as rivers, pans, swamp forests, mangrove swamps, estuaries, dams and tidal mudflats. Short grass close to the water.
88	*Ephippiorhynchus senegalensis*	Saddlebilled Stork	Common	Larger inland waters, rivers, dams, floodplains, swamps, usually in open or lightly wooded country
89	*Leptoptilos crumeniferus*	Marabou Stork*	Common	Aquatic and terrestrial habitats, open and semi-arid areas. Associates with humans near fishing villages, refuse dumps, abattoirs. Woodland vegetation.
90	*Mycteria ibis*	Yellowbilled Stork*	Common	Diverse habitat, dams, large marshes, swamps, estuaries, margins of lakes or rivers, seasonal wetlands, small ponds.
91	*Threskiornis aethiopicus*	Sacred Ibis	Common	Grassland habitat associated with freshwater habitats, especially marshes, but also forages in dryland grasslands and in intertidal salt marshes at estuaries. Farm dams, sewerage works and cultivated fields.
93	*Plegadis falcinellus*	Glossy Ibis*	Common	Wetlands in grasslands and floodplains. Prefers freshwater habitat. Favours shallow inland waters.
94	*Bostrychia hagedash*	Hadeda Ibis	Common	Open, moist grasslands and savannas, especially along well vegetated river

				courses, but also marshes, flooded grasslands, edges of large wetlands, irrigated agricultural lands and lawns in gardens.
95	*Platalea alba*	African Spoonbill	Common	Forager in shallow aquatic habitats. Freshwater wetlands, marshes pans, temporary flooded grasslands, floodplains, rivers, sewerage ponds and dams. Less frequent in saltwater habitats including estuaries and coastal lagoons.
97	*Phoeniconaias minor*	Lesser Flamingo*	Lower risk (nt)	Larger brackish or saline inland and coastal waters
99	*Dendrocygna viduata*	Whitefaced Duck	Common	Wide variety of waterbodies, favours large expanses of shallow water. Nests in grassland and woodland.
100	*Dendrocygna bicolor*	Fulvous Duck	Common	Large inland waters floodplains with plentiful aquatic vegetation. Wetlands.
102	*Alopochen aegyptiacus*	Egyptian Goose	Common	Inland water: rivers, pans, dams, lakes, estuaries, sewerage pans, preferably with some exposed shoreline. Often foraging in farmlands.
104	*Anas undulata*	Yellowbilled Duck	Common	Inland waters, especially farm dams, also on estuaries mostly with marginal vegetation, especially reeds. Occurs in mostly freshwater, but may also be found in brackish water, prefers slow flowing streams.
105	*Anas sparsa*	African Black Duck	Common	Associated mainly with rivers, especially with running water, pools and wooded banks. May roost on farm dams at night.
106	*Anas capensis*	Cape Teal	Common	Saltpans, estuaries and coastal lagoons. Inland it favours brackish or saline pans and dams, adapted to sewerage works.
107	*Anas hottentota*	Hottentot Teal	Common	Permanent and semi-permanent quiet inland waters with emergent vegetation. Floodplains, vleis, marshes and sewerage ponds.
108	*Anas erythrorhyncha*	Redbilled Teal	Common	Prefers permanent or temporary eutrophic fresh waters, usually with grassy surrounds for nesting.
112	*Anas smithii*	Cape Shoveller	Common	Shallow lowland plankton filled freshwaters. Shallow pans (especially with salt water) and dams in open grasslands
113	*Netta erythrophthalma*	Southern Pochard	Common	Deeper inland waters, flooded vleis, dams, sewerage ponds, prefers clear water
114	*Nettapus auritus*	Pygmy Goose	Common	Clear still inland waters with surface or emergent vegetation. Open waters and coastal lagoons.
116	*Plectropterus gambensis*	Spurwinged Goose	Common	Any inland waters and prefers larger bodies of water on which to gather for moulting. It forages in croplands and on floating Potamogeton pectinatus.
117	*Oxyura maccoa*	Maccoa Duck	Common	Deep, highly eutrophic inland waters, small dams, lakes, sewerage ponds
118	*Sagittarius serpentarius*	Secretarybird	Common	Semi-desert, grassland, savanna, open woodland, farmland, mountain slopes
122	*Gyps coprotheres*	Cape Vulture	Vulnerable	Mountainous country, open country with inselbergs and escarpments, less commonly in savanna or desert

123	*Gyps africanus*	Whitebacked Vulture	Common	Wide variety of vegetation types, preferring drier woodlands.
124	*Torgos tracheliotus*	Lappetfaced Vulture	Common	Hot, dry woodlands, Mopane and arid mixed woodlands. Usually low altitudes, except the higher lying Kalahari basin.
127	*Elanus caeruleus*	Blackshouldered Kite	Common	In a variety of habitats. Most abundant in grasslands and fynbos, especially where cultivated areas are interspersed with these habitats.
128	*Aviceda cuculoides*	Cuckoo Hawk	Common	
131	*Aquila verreauxii*	Black Eagle	Common	Rocky habitat in hills and mountains, with dense and dependable source of prey (Dassie)
132	*Aquila rapax*	Tawny Eagle	Common	Woodlands, including lightly wooded areas
133	*Aquila nipalensis*	Steppe Eagle*	Common	Woodland and open savanna, including semi-arid savanna
135	*Aquila wahlbergi*	Wahlberg's Eagle*	Common	Most woodland types. Higher rainfall areas. Riverlines and floodplains with riparian vegetation.
136	*Hieraaetus pennatus*	Booted Eagle*	Common	Hilly and open country, breeds on cliffs in ravines and gorges. Wide variety of habitats.
137	*Hieraaetus spilogaster*	African Hawk Eagle	Common	Range of woodland habitats. Favours Mopane habitat. Nests on hill slopes or along water courses in flat terrain
139	*Lophaetus occipitalis*	Longcrested Eagle	Common	Woodland, exotic plantations, forest edge, cultivate land with orchards, woodland, grassland and vleis
140	*Polemaetus bellicosus*	Martial Eagle	Common	Open grassland and scrub and woodland. Typically in flat country
142	*Circaetus cinereus*	Brown Snake Eagle	Common	Prefers moderately arid woodland
143	*Circeatus pectoralis*	Blackbreasted Snake Eagle	Common	Open country mostly in savanna woodlands, dwarf shrublands and semi-desert
146	*Terathopius ecaudatus*	Bateleur	Common	Variety of woodlands from open semi-arid to mesic
148	*Haliaeetus vocifer*	African Fish Eagle	Common	Estuaries, coastal and inland lakes, larger rivers and pans, floodplains and artificial impoundments.
149	*Buteo buteo*	Steppe Buzzard*	Common	Open country, favouring mainly dwarf shrubland, grassland, savanna, open woodland, thornveld and fynbos. It can also be found in dense woodland and forests, including exotic plantations. Croplands, especially wheatlands where food is abundant.
152	*Buteo rufofuscus*	Jackal Buzzard	Common	Mountainous or hilly areas, especially covered by grass and other short vegetation. Nests on cliffs and trees.
154	*Kaupifalco monogrammicus*	Lizard Buzzard	Common	Broadleaved woodland.
156	*Accipiter ovampensis*	Ovambo Sparrowhawk	Common	Mosaic of tall woodland and open areas. Tall alien trees for breeding. Ecotone between woodland and grassland biomes.

157	*Accipiter minullus*	Little Sparrowhawk	Common	Dense vegetation of forest, riparian bush and thickets
158	*Accipiter melanoleucus*	Black Sparrowhawk	Common	Tall, dense vegetation, forest, riparian growth and well developed woodlands.
159	*Accipiter badius*	Little Banded Goshawk	Common	All woodland types.
160	*Accipiter tachiro*	African Goshawk	Common	Areas of dense vegetation, forest, well-developed woodland, riparian growth and thickets
161	*Micronisus gabar*	Gabar Goshawk	Common	Open woodland, especially Acacia woodland
162	*Melierax canorus*	Pale Chanting Goshawk	Common	All arid areas, Kalahari and Karoo vegetation types especially. Drier woodland and grassland types. Open scrub and wooded drainage lines.
163	*Melierax metabates*	Dark Chanting Goshawk	Common	Variety of woodland habitat, but tends to avoid both arid and forested areas. Preference for tall, well-developed woodland.
165	*Circus ranivorus*	African Marsh Harrier	Common	Nests in extensive reedbeds, short sedges areas.
169	*Polyboroides typus*	Gymnogene	Common	Forests, dense woodland, riparian vegetation and well-wooded ravines. Often inhabit cliff faces in mountainous terrain, but also inhabits flat plains.
172	*Falco biarmicus*	Lanner Falcon	Common	Cliff-nester, also trees and electricity pylons. Open habitats
180	*Falco amurensis*	Eastern Redfooted Kestrel*	Common	Open and high rainfall grasslands, also open woodland.
181	*Falco tinnunculus*	Rock Kestrel	Common	Wide variety of habitats. Capable of inhabiting the entire span of mesic to arid conditions. Distribution is strongly influence by mountainous areas for breeding.
182	*Falco rupicoloides*	Greater Kestrel	Common	Open, arid and grassland habitats
183	*Falco naumanni*	Lesser Kestrel*	Vulnerable	Open grassveld, mainly on highveld, usually near towns or farms
188	*Francolinus coqui*	Coqui Francolin	Common	Savanna or well grassed woodlands, or sandy areas with good bush cover.
189	*Francolinus sephaena*	Crested Francolin	Common	Woodland with a dense scrub component. Favours areas with bush encroachment in savannas, and tolerates poor grass cover
196	*Francolinus natalensis*	Natal Francolin	Common	Ranges from savanna with a scrub understorey, especially along watercourses, to thickets and coastal forest. Dry riparian vegetation and wooded hills, and edges of montane forest, edges of agricultural fields adjacent to dense vegetation.
199	*Francolinus swainsonii*	Swainson's Francolin	Common	Tall grass, open country or woodland. Usually close to water (except in the arid west).
200	*Coturnix coturnix*	Common Quail*	Common	Open grassland, lightly wooded savanna, cultivated fields, non breeding birds also occur in the karoo, Kalahari sandveld and semi-desert
203	*Numida meleagris*	Helmeted Guineafowl	Common	Open grassland, vleis, savanna, cultivated lands, edge of karoo scrub, bushveld
205	*Turnix sylvatica*	Kurrichane Buttonquail	Common	Drier grasslands, fallow lands, light savanna or woodland

208	*Anthropoides paradiseus*	Blue Crane	Vulnerable	Midland and highland grassveld, edge of karoo, cultivated lands, edges of vleis
210	*Rallus caerulescens*	African Rail	Common	Reedbeds and dense rank growth in permanent or seasonal swamps and marshes, and besides rivers, streams, pools and lakes.
213	*Amaurornis flavirostris*	Black Crake	Common	Freshwater and estuarine wetland vegetation.
215	*Porzana pusilla*	Baillon's Crake*	Common	Reedbeds, marshes, vleis
223	*Porphyrio porphyrio*	Purple Gallinule	Common	Fresh-brackish, sheltered, still-slow flowing waters fringed or overgrown by reeds, rushes, sedges etc.
226	*Gallinula chloropus*	Moorhen	Common	Wide range of natural and artificial wetlands, with fringing vegetation.
228	*Fulica cristata*	Redknobbed Coot	Common	Predominantly open fresh water of lakes, lagoons, ponds, permanent and temporary pans, dams and vleis, floodplains, reedy swamps and sewerage ponds, sometimes on rivers and tidal lagoons, but prefers still water. Submerged aquatic vegetation for food.
229	*Podica senegalensis*	African Finfoot	Common	Quiet reaches of streams, rivers, pans and lakes, fringed with dense trees and bush dropping into water
230	*Ardeotis kori*	Kori Bustard	Common	Dry savanna, not closed canopy woodland
231	*Neotis denhami*	Stanley's Bustard	Common	Montane and highland grassveld, savanna, karoo scrub
233	*Eupodotis cafra*	Whitebellied Korhaan	Common	Open grassland, sometimes in sparse Acacia thornveld
237	*Eupodotis ruficrista*	Redcrested Korhaan	Common	Bushveld and scrub within woodland biomes
239	*Eupodotis afra*	Black Korhaan	Common	Shrublands of the fynbos and Karoo biomes, grass and tree cover virtually absent.
240	*Actophilornis africanus*	African Jacana	Common	Lagoons, lakes, pans, vleis, river backwaters
241	*Microparra capensis*	Lesser Jacana	Common	Shallow lagoons, vleis, dams, lakes
246	*Charadrius marginatus*	Whitefronted Plover	Common	Along sandy rivers, wetlands, muddy and sandy substrates
248	*Charadrius pecuarius*	Kittlitz's Plover	Common	Natural pans, dried mud and short grass. Adapted to dams and open mowed areas. Salt marshes, saltpans and estuaries
249	*Charadrius tricollaris*	Threebanded Plover	Common	Widest range of aquatic habitats may be seen at any freshwater habitat with an open shoreline. Artificial waterbodies, e.g. farm dams.
254	*Pluvialis squatarola*	Grey Plover*	Common	Tidal flats on coast and estuaries, open sandy beaches, rocky shores, less commonly on larger shallow inland waters
255	*Vanellus coronatus*	Crowned Plover	Common	Dry, short and overgrazed or burnt grassland, as well as sports fields, golf courses and airports. Breeding sites in open habitats, with a commanding view in all directions.
258	*Vanellus armatus*	Blacksmith Plover	Common	Moist short grassland and mudflats on the edges of dams, pans, lakes, rivers and estuaries. Natural and irrigated grasslands, sports fields, golfcourses,

				airports.
260	*Vanellus senegallus*	Wattled Plover	Common	Wet short grassland and marshes, near to vleis, stream and river floodplains.
264	*Actitis hypoleucos*	Common Sandpiper*	Common	Open wet edges, streams, rivers, marshes, dams, sewerage works, vleis, lagoons, estuaries
266	*Tringa glareola*	Wood Sandpiper*	Common	Marshy shorelines of pans, vleis, dams, stream, floodplains.
269	*Tringa stagnatilis*	Marsh Sandpiper*	Common	Wide variety of freshwater wetlands, also slat works, lagoons and tidal estuaries.
270	*Tringa nebularia*	Greenshank*	Common	Wide variety of aquatic habitat. Coastal sites and inland wetlands.
272	*Calidris ferruginea*	Curlew Sandpiper*	Common	Wetlands along the coast and in highveld pans
274	*Calidris minuta*	Little Stint*	Common	Muddy edges of wetlands
284	*Philomachus pugnax*	Ruff(m), Reeve(f)*	Common	Shallow water, muddy margins and short emergent vegetation
286	*Gallinago nigripennis*	Ethiopian Snipe	Common	Temporary and permanent wetlands with short emergent vegetation, grass or reeds and exposed soft mud
294	*Recurvirostra avosetta*	Avocet*	Common	Saline waters
295	*Himantopus himantopus*	Blackwinged Stilt	Common	Extensive open shallow waters
297	*Burhinus capensis*	Spotted Dikkop	Common	Open grassland and savanna, edges of woodland, semi-desert with scrub, stoney slopes of low hills. Cultivated and overgrazed land, large lawns and playing fields. Marine beaches.
298	*Burhinus vermiculatus*	Water Dikkop	Common	Rivers, dams, lakes, pans, estuaries, mangrove swamps, beaches
300	*Cursorius temminckii*	Temminck's Courser	Common	Bare or recently burnt grass in open woodland or at the edges of vleis, grassy plains, bare or overgrazed veld, fallow land and airfields.
303	*Rhinoptilus chalcopterus*	Bronzewinged Courser*	Common	Frequent in Mopane woodland. Open woodland. Feed on dirt roads at night.
315	*Larus cirrocephalus*	Greyheaded Gull	Common	Shallow open water
339	*Childonias leucopterus*	Whitewinged Tern*	Common	Inland and coastal wetlands
343	*Rynchops flavirostris*	African Skimmer	Lower Risk (nt)	Lowveld rivers on bare, open sandbanks. May have been displaced to highveld dams.
345	*Pterocles burchelli*	Burchell's Sandgrouse	Common	Arid sweet bushveld, dry savanna
346	*Pterocles gutturalis*	Yellowthroated Sandgrouse	Common	Short-grass plains, usually not far from water, also recently burnt ground, cultivated fields, especially on black clay soils.
347	*Pterocles bicinctus*	Doublebanded Sandgrouse	Common	Acacia and other savanna, dry bushveld, mopane woodland, stony and eroded areas, rocky desert hills with scrub and tussocky hills
348	*Columba livia*	Feral Pigeon	Common	Central urban and industrial areas
349	*Columba guinea*	Rock Pigeon	Common	Formerly mainly an inhabitant of cliffs and crags. Now inhabits artificial structures and exotic trees for nesting and roosting.

352	*Streptopelia semitorquata*	Redeyed Dove	Common	Tall trees in the vicinity of water. Suburban parks and gardens. Riparian woodland, forest verges and other well wooded country including alien tree plantations.
354	*Streptopelia capicola*	Cape Turtle Dove	Common	Inhabits all areas, avoiding forest.
355	*Streptopelia senegalensis*	Laughing Dove	Common	Open savanna and Acacia thornveld. Cultivated fields.
356	*Oena capensis*	Namaqua Dove	Common	Dry bushveld, Acacia thornveld, arid scrub, semidesert, riverine bush in desert, rural gardens, farmyards, fallow lands
358	*Turtur chalcospilos*	Greenspotted Dove	Common	Most woodland, Acacia scrub, gardens, not forest (except dry sand forest in Thongaland) or arid savanna
361	*Treron calva*	Green Pigeon	Common	Woodland, especially riverine fig forest, also edges of evergreen forest
364	*Poicephalus meyeri*	Meyer's Parrot	Common	Savanna woodland, riverine forest, secondary growth around cultivation, dry Acacia scrub with taller trees (especially Baobabs), usually near water
373	*Corythaixoides concolor*	Grey Lourie	Common	Bushveld, savanna, riverine woodland in arid country
375	*Cuculus gularis*	African Cuckoo*	Common	Variety of woodlands.
377	*Cuculus solitarius*	Redchested Cuckoo*	Common	Range of forest and well-wooded habitat. Trees around habitation in drier areas
378	*Cuculus clamosus*	Black Cuckoo*	Common	Plantations, human habitation, bushveld, woodland and thornveld
380	*Clamator glandarius*	Great Spotted Cuckoo*	Common	Woodland and savanna
382	*Clamator jacobinus*	Jacobin Cuckoo*	Common	Dry open savannas
385	*Chrysococcyx klaas*	Klaas's Cuckoo*	Common	Edges of riverine forest, thickets, dense woodland and savanna, wooded rocky hills
386	*Chrysococcyx caprius*	Diederik Cuckoo*	Common	Woodland, savanna, riverine bush, gardens, parks, farmlands, exotic plantations, semi-arid scrub
391	*Centropus burchellii*	Burchell's Coucal	Common	Riverine and coastal bush, rank growth around streams and marshes, reedbeds, gardens, parks
392	*Tyto alba*	Barn Owl	Common	Varied, but always near suitable nesting cavity in cliff, building, deep well, mine shaft, Sociable Weaver or Hammerkop nest, hole in tree, base of palm frond; from woodland to desert, but not forest
393	*Tyto capensis*	Grass Owl	Common	Long grass, usually near water, vleis or marshes
395	*Asio capensis*	Marsh Owl	Common	Grassland, vleis, edges of marshes
396	*Otus senegalensis*	African Scops Owl	Common	Range of woodland types, where trees are relatively tall and scattered. Forests are avoided. Nests in cavities in trees.
397	*Otus leucotis*	Whitefaced Owl	Common	Range of woodland vegetation types. Moist and open habitats are avoided.
398	*Glaucidium perlatum*	Pearlspotted Owl	Common	Bushveld, woodland, Acacia savanna

401	*Bubo africanus*	Spotted Eagle Owl	Common	Man made habitats roosting and nesting in gardens, quarries and buildings.. Great variety of nest sites; scrapes on the ground, cavities and stick nests in trees, and cavities and ledges on cliffs and buildings
402	*Bubo lacteus*	Giant Eagle Owl	Common	Roosts and nests in large trees, in open savanna woodlands or riparian woodlands adjacent to floodplains.
404	*Caprimulgus europaeus*	European Nightjar*	Common	Woodland, savanna, tree lined watercourses, plantations, gardens
405	*Caprimulgus pectoralis*	Fierynecked Nightjar	Common	Dense woodland, plantations, gardens, thornveld, bushveld
406	*Caprimulgus rufigena*	Rufouscheeked Nightjar	Common	Open woodland, savanna, exotic plantations, semi-arid scrub, shrubby semidesert
408	*Caprimulgus trstigma*	Freckled Nightjar	Common	Wooded and bushy rocky hills, koppies, outcrops, escarpments
409	*Caprimulgus fossii*	Mozambique Nightjar	Common	Scrub with open sandy ground in savanna, riverine bush, coastal dunes
411	*Apus apus*	European Swift*	Common	Open often semi-arid country. Sleeps on the wing
412	*Apus barbatus*	Black Swift	Common	Montane areas. Breeds in dry horizontal cracks under overhangs of cliffs or in caves. Forages over open country.
415	*Apus caffer*	Whiterumped Swift*	Common	Forager on aerial invertebrates and can be found anywhere. More common in the more humid areas.
417	*Apus affinis*	Little Swift	Common	Forager on aerial invertebrates and can be found anywhere. Prefers the more open grasslands and Karoo. Nest in dry overhangs, cliff faces and human constructions (bridges, silos).
418	*Apus melba*	Alpine Swift	Common	Alpine grasslands and Fynbos. Breeds in dry vertical cracks in overhanging cliffs, sometimes horizontal ones. Tall buildings and grain silos.
421	*Cypsiurus parvus*	Palm Swift	Common	Palm trees, both indigenous and exotic, mostly at lower elevations, gardens and parks
424	*Colius striatus*	Speckled Mousebird	Common	Bushveld, tangled thickets, edges of dense vegetation, gardens, orchards
425	*Colius colius*	Whitebacked Mousebird	Common	Arid to semi-arid scrub, riverine bush, farmyards, gardens, orchards
426	*Urocolius indicus*	Redfaced Mousebird	Common	Savanna with thickets, riverine bush, gardens, orchards
427	*Apaloderma narina*	Narina Trogon	Common	Evergreen, lowland or montane forest. Riverine forests in savanna, closed woodlands, and forest-woodland mosaics.
428	*Ceryle rudis*	Pied Kingfisher	Common	Closely associated with aquatic environments, entirely dependent on the availability of fish. Large rivers and perennial streams, estuaries, man-made canals, lakes and reservoirs, intertidal zone of the coast.
429	*Megaceryle maxima*	Giant Kingfisher	Common	Large rivers and their major tributaries, particularly with well wooded steep banks, may also be found in small streams. Estuaries and the intertidal zone. Lakes and reservoirs.
431	*Alcedo cristata*	Malachite Kingfisher	Common	River and stream banks, sluggish water and overhung with trees and

				riverine grass and weedy vegetation
432	*Ispidina picta*	Pygmy Kingfisher*	Common	Edges and clearing in dense woodland, coastal bush and forest, also riverine forest, edges of cultivated land in forests, dry savanna in old Transvaal
433	*Halcyon senegalensis*	Woodland Kingfisher*	Common	Well-developed woodland, especially where the grass understorey is well grazed.
435	*Halcyon albiventris*	Brownhooded Kingfisher	Common	Edges of evergreen forest and plantations. Woodland and riverine woodland. Degraded areas with sparse tree cover.
436	*Halcyon leucocephala*	Greyhooded Kingfisher*	Common	Well developed woodland, Acacia, Mesic woodland
437	*Halcyon chelicuti*	Striped Kingfisher	Common	Open woodland in mesic and arid conditions
438	*Merops apiaster*	European Bee-eater*	Common	Woodland and shrubby habitats, avoids mesic and arid areas
441	*Merops nubicoides*	Carmine Bee-eater*	Common	Frequents open woodland and savannas, floodplains and Acacia steppe. For nesting it favours high, fresh-cut sand cliffs, preferably free of vegetation, large meandering rivers. Open grassy places in a variety of woodland types. Sandy flats for breeding
443	*Merops bullockoides*	Whitefronted Bee-eater	Common	Watercourses in woodland and wooded grassland
444	*Merops pusillus*	Little Bee-eater	Common	Semi-arid to high rainfall areas. Low and high altitudes. Open spaces (foraging) with low bushes or reeds (perching), low sandbanks or Aardvark burrows (nesting).
445	*Merops hirundineus*	Swallowtailed Bee-eater	Common	Well-developed woodland. Variety of woodland types.
446	*Coracias garrulus*	European Roller*	Common	Woodland, bushveld and grassland habitats. Avoids open arid region in the west
447	*Coracias caudata*	Lilacbreasted Roller	Common	Prefers the ecotone between light-woodland and open grassy areas. Tends to avoid rocky areas
449	*Coracias naevia*	Purple Roller	Common	Low preference for woodland-grassland ecotone, prefers more uniform bushveld and woodland. Absent in high altitudes and in forests.
451	*Upupa epops*	Hoopoe	Common	Savanna, open woodland, gardens, parks, Kalahari thornveld, riverine woodland in arid areas
452	*Phoeniculus purpureus*	Redbilled Woodhoopoe	Common	Most woodland types, excluding the montane forests of the east.
454	*Rhinopomastus cyanomelas*	Scimitarbilled Woodhoopoe	Common	Found in tropical and sub-tropical arid woodland. Not in woodlands with a completely closed canopy.
457	*Tockus nasutus*	Grey Hornbill	Common	Tall woodland in dry to humid savannas
458	*Tockus erythrorhynchus*	Redbilled Hornbill	Common	Woodland with sparse ground cover.
459	*Tockus leucomelas*	Southern Yellowbilled Hornbill	Common	Dry, open savanna woodlands
464	*Lybius torquatus*	Blackcollared Barbet	Common	Moist woodland areas and riverine vegetation in drier savannas and grassland. Human habitations

465	*Tricholaema leucomelas*	Pied Barbet	Common	Varied ecological conditions. Arid savannas with soft-wooded trees. Wooded drainage lines in grasslands and other open habitats.
470	*Pogoniulus chrysoconus*	Yellowfronted Tinker Barbet	Common	Broadleaved woodlands
473	*Trachyphonus vaillantii*	Crested Barbet	Common	Savanna, woodland and thickets, particularly in the broad-leaved woodlands.
474	*Indicator indicator*	Greater Honeyguide	Common	Range of woodland types outside of dense forest.
476	*Indicator minor*	Lesser Honeyguide	Common	Wide range of wooded habitats, from savannas with scattered tree to forest fringes, riverine woodland.
481	*Campethera bennettii*	Bennett's Woodpecker	Common	Mature woodland and parkland dominated by broadleaved trees and Acacia, and woodlands underlain by sandy soils.
483	*Campethera abingoni*	Goldentailed Woodpecker	Common	Wide spectrum of woodland and savanna habitats
486	*Dendropicos fuscescens*	Cardinal Woodpecker	Common	Woodland and savanna habitats.
487	*Thripias namaquus*	Bearded Woodpecker	Common	More arid savanna types. Restricted to savanna and woodland, found in areas with tall tree and park-like settings. Avoids plantations.
489	*Jynx ruficollis*	Redthroated Wryneck	Common	Thornveld, open bushveld, exotic plantations, gardens, farmyards
493	*Mirafra passerina*	Monotonous Lark	Common	Wide variety of fairly dry and open woodlands with bare and stony patches. After rain also occurs in arid open woodland with fairly dense grass cover.
494	*Mirafra africana*	Rufousnaped Lark	Common	Variety of habitats with bare patches, sparse grass cover and perches
495	*Mirafra apiata*	Clapper Lark	Common	Grassland with scattered boulders and bushes
496	*Mirafra rufocinnamomea*	Flappet Lark	Common	Woodland with clearing or drainage lines
497	*Mirafra africanoides*	Fawncoloured Lark	Common	Open savanna, woodlands and shrublands. Forages on bare patches or patches with sparse grass cover.
498	*Mirafra sabota*	Sabota Lark	Common	Wide range of savanna habitats
507	*Calandrella cinerea*	Redcapped Lark	Common	Short grasslands that have been heavily grazed or burned, ploughed lands and fallow fields
508	*Spizocorys conirostris*	Pinkbilled Lark	Common	Open grassland in semi arid and high rainfall regions
515	*Eremopterix leucotis*	Chestnutbacked Finchlark	Common	Open savanna woodlands with bare areas
516	*Eremopterix verticalis*	Greybacked Finchlark	Common	Arid gravelly or stony ground with sparse shrubs and grass, open short grass plains, bare pans, burnt areas, fallow lands
518	*Hirundo rustica*	European Swallow*	Common	Almost every habitat, more common in higher rainfall
520	*Hirundo albigularis*	Whitethroated Swallow*	Common	Vicinity of wetlands, especially rivers and other expanses of open water. More common in open habitat
523	*Hirundo dimidiata*	Pearlbreasted Swallow*	Common	Clearings and woodland edges. Broad-leaved woodlands, wetland sites and open areas.

524	*Hirundo semirufa*	Redbreasted Swallow*	Common	Open savanna and sweet grassveld
526	*Hirundo cucullata*	Greater Striped Swallow*	Common	Wide variety of fairly open habitats
527	*Hirundo abyssinica*	Lesser Striped Swallow*	Common	Woodland and savanna habitats. Also in cultivated and sub urban areas
528	*Hirundo spilodera*	South African Cliff Swallow*	Common	Dry grassland and lightly wooded savanna
529	*Hirundo fuligula*	Rock Martin	Common	Vegetation with frequent rock formations as well as urban and farming areas.
530	*Delichon urbica*	House Martin*	Common	Wide variety of habitats, common in hilly open country
531	*Pseudhirundo griseopyga*	Greyrumped Swallow	Common	Open areas- burnt and cleared areas, floodplains
533	*Riparia paludicola*	Brownthroated Martin	Common	Associated with water near streams, large rivers, dams, estuaries and sewerage works
538	*Campephaga flava*	Black Cuckooshrike*	Common	Canopy of moist woodlands, becoming sparser in drier regions, but occurring in both broadleaves and Acacia woodland
541	*Dicrurus adsimilis*	Forktailed Drongo	Common	Wide range of vegetation types, edges of forest, alien trees.
545	*Oriolus larvatus*	Blackheaded Oriole	Common	Moist woodland preferably evergreen or lightly deciduous.
547	*Corvus capensis*	Black Crow	Common	Open habitat with scattered patches of trees or wooded watercourses
548	*Corvus albus*	Pied Crow	Common	Wide variety of biomes
550	*Corvus albicollis*	Whitenecked Raven	Common	Cliff nesters restricted to hilly and mountainous areas.
552	*Parus cinerascens*	Ashy Tit	Common	Acacia trees and thickets. Wide range of woodland and grassland habitats
554	*Parus niger*	Southern Black Tit	Common	Broad-leaved woodlands. Scarcer in more arid savanna vegetation types.
557	*Anthoscopus minutus*	Cape Penduline Tit	Common	Arid and semi-arid habitat
558	*Anthoscopus caroli*	Grey Penduline Tit	Common	Well-developed broad-leaved woodland.
560	*Turdoides jardeneii*	Arrowmarked Babbler	Common	Thickets or strips of denser vegetation along seasonal drainage lines in drier habitats. Found in a variety of woodland types.
563	*Turdoides bicolor*	Pied Babbler	Common	Thornbush, avoid mesic woodlands
567	*Pycnonotus nigricans*	Redeyed Bulbul	Common	Dry woodland, arid savanna, thickets, scrub, riverine bush, gardens and farmyards. Near water in the dry season
568	*Pycnonotus barbatus*	Blackeyed Bulbul	Common	Moister woodland and savanna, riverine bush, forest edge, dense montane scrub, plantations, gardens, orchards, scrubby vegetation
569	*Phyllastrephus terrestris*	Terrestrial Bulbul	Common	Evergreen forest, dense riparian and thickets
574	*Chlorocichla flaviventris*	Yellowbellied Bulbul	Common	lowland forest, termitaria, thickets, riverine
576	*Turdus libonyana*	Kurrichane Thrush	Common	Woodland and thickets, avoids forest, grassland and savanna. Adapted to plantations and human habitation
577	*Turdus olivaceus*	Olive Thrush	Common	Riverine bush and montane forest. Adapted to human habitations (gardens)
580	*Turdus litsitsirupa*	Groundscraper Thrush	Common	Open "parkland" woodlands, prefers underdeveloped understorey, patches

				of bare ground
581	*Monticola rupesris*	Cape Rock Thrush	Common	Rocky mountainous habitats in high rainfall regions, also in gorges, incised river valleys, foothills and in lowlands adjacent to mountains.
583	*Monticola brevipes*	Shorttoed Rock Thrush	Common	Broken ground with trees or tall scrub in areas of relatively low rainfall
586	*Oenanthe monticola*	Mountain Chat	Common	Rocky habitats in mountains, hills, quarries, scarps, boulder-strewn level ground.
587	*Oenanthe pileata*	Capped Wheatear	Common	Open areas with bare ground, including those resulting from trampling, burning or overgrazing.
588	*Oenanthe bifasciata*	Buffstreaked Chat	Common	Rocky slopes of hills, ridges, escarpments and mountain foothills, with rolling grassland and low scattered bushes
589	*Cercomela familiaris*	Familiar Chat	Common	Broken ground and rocky habitat, open vegetation types, close to water
593	*Thamnolaea cinnamomeiventris*	Mocking Chat	Common	Rocky outcrops in wooded country, relatively open, well-faulted rock faces with scattered trees and shrubs
595	*Myrmecocichla formicivora*	Anteating Chat	Common	Open habitats with some grass and scrub
596	*Saxicola torquata*	Stonechat	Common	Usually high altitude grasslands, moist open country with rank growth of grass and herbs and scattered shrubs.
601	*Cossypha caffra*	Cape Robin	Common	Coastal fynbos, farmstead woodlots, Leucosidea scrub in alpine grassland, bracken-briar fringe of Afromontane forest. Cover loving species.
602	*Cossypha humeralis*	Whitethroated Robin	Common	Thickets lining dry water courses in the bushveld and thornveld. Also open woodland and the fringes of sand forest
613	*Erythropygia leucophrys*	Whitebrowed Robin	Common	Woodland and bushveld habitats in dense undergrowth
615	*Erythropygia paena*	Kalahari Robin	Common	Bare or almost bare ground in Kalahari sandveld
619	*Sylvia borin*	Garden Warbler*	Common	Lush woodlands, rare in dry areas where it is limited to riverine vegetation or human habitation
621	*Parisoma subcaeruleum*	Titbabbler	Common	Scrub and thickets
625	*Hippolais icterina*	Icterine Warbler*	Common	Tall stands of tree in dry woodlands. In drier more shrubby areas it is restricted to taller riverine vegetation
628	*Acrocephalus arundinaceus*	Great Reed Warbler*	Common	In drier areas restricted to taller swamp vegetation. In the more mesic areas found in lush thickets and tall grassy vegetation away from water.
631	*Acrocephalus baeticatus*	African Marsh Warbler*	Common	Reedbeds and other dense vegetation associated with wetlands. Also in dense, lush scrub or tall grass away from water
633	*Acrocephalus palustris*	European Marsh Warbler*	Common	Dense lush thickets, particularly with rank herbaceous undergrowth, usually away from water.
635	*Acrocephalus gracilirostris*	Cape Reed Warbler	Common	Reedbeds and bulrushes in lagoons of standing water, estuaries, rivers, dams, pans, marshes, vleis etc.

638	*Bradypterus baboecala*	African Sedge Warbler	Common	Reedbeds and swamp vegetation
643	*Phylloscopus trochilus*	Willow Warbler*	Common	Any habitat with bushes or trees
645	*Apalis thoracica*	Barthroated Apalis	Common	Any wooded habitats.
651	*Sylvietta rufescens*	Longbilled Crombec	Common	Preference for woodland and scrubland habitat
653	*Eremomela icteropygialis*	Yellowbellied Eremomela	Common	Wide range of habitats from woodland to low scrub
656	*Eremomela usticollis*	Burntnecked Eremomela	Common	Wide range of woodland, especially Acacia woodland, particularly along drainage lines
657	*Camaroptera brachyura*	Bleating Warbler	Common	Evergreen forest, stands of alien trees and other patches of suitable habitats
658	*Calamonastes fasciolatus*	Barred Warbler	Common	Kalahari basin thornveld endemic, restricted to Acacia bushveld. Predominantly broadleaved vegetation.
661	*Sphnoeacus afer*	Grassbird	Common	Rank vegetation with long grasses, restions or ferns, in tangled scrub, low sparse shrublands and in hilly grasslands with scattered bushes. Avoids high dense weedy areas.
664	*Cisticola juncidis*	Fantailed Cisticola	Common	Natural tall grasslands and weedy areas. Edges of waterbodies, and also man made habitats (agricultural fields)
665	*Cisticola aridula*	Desert Cisticola	Common	Mainly in open, dry, short grasslands and savanna with a low basal cover
666	*Cisticola textrix*	Cloud Cisticola	Common	Short grasslands with relatively low basal cover. Open grassland and avoids invasion by scrub and trees.
667	*Cisticola ayresii*	Ayres' Cisticola	Common	Short, moist and relatively dense grasslands in well drained soils
671	*Cisticola rufilata*	Tinkling Cisticola	Common	Scrub in open woodland, arid deciduous woodland on sandy soils. Broad-leaved deciduous savanna or scrub with open areas of rank grass between scattered low trees.
672	*Cisticola chiniana*	Rattling Cisticola	Common	Tree savanna, grassland interspersed with trees and thickets or scrub. Fringes of dense woodland and in coastal scrub patches.
674	*Cisticola erythrops*	Redfaced Cisticola	Common	Rank growth and reeds along the edges of streams, rivers and marshes, or in weeds and long tangled vegetation on damp ground.
677	*Cisticola tinniens*	Levaillant's Cisticola	Common	Rank grass and weeds, sedges and edges of reedbeds on marshy grounds, or emergent vegetation in water
679	*Cisticola aberrans*	Lazy Cisticola	Common	Rocky slopes with grass, dense scrub and occasional trees and thickets, sometimes also along valley bottoms and in gullies
681	*Cisticola fulvicapilla*	Neddicky	Common	Dune scrub, scrub, rank grass on hill slopes and on the edges of woodlands and plantations, in secondary growth and in thornveld
683	*Prinia subflava*	Tawnyflanked Prinia	Common	Higher rainfall areas and taller dense patches of vegetation. Rank grass on the edges of roads or farmlands, drainage lines, the edges of dams and rivers and scrubby patches within woodland savanna, thickets, reeds and sedges of

				wetlands.
685	*Prinia flavicans*	Blackchested Prinia	Common	Scrub, rank grass, low bushes and secondary growth in open woodland and grassland. A wide array of low rainfall vegetation types
689	*Muscicapa striata*	Spotted Flycatcher*	Common	Open woodland or habitat with tree with bare branches
691	*Muscicapa caerulescens*	Bluegrey Flycatcher*	Common	Woodland habitats, coastal forests, riverine strips, dense thickets, seldom uses alien vegetation
694	*Melaenornis pammelaina*	Black Flycatcher	Common	Woodlands near surface water mostly
695	*Melaenornis mariquensis*	Marico Flycatcher	Common	Acacia bushveld and woodland
698	*Sigelus silens*	Fiscal Flycatcher	Common	Fairly open vegetation, with trees or intermittent scrub on which to perch. Watercourses are used on drier areas.
700	*Batis capensis*	Cape Batis	Common	Valley bushveld and dense thornveld. Particularly a bird of evergreen forest, with undergrowth tangles also uses the canopy. Can survive in small forest fragments.
701	*Batis molitor*	Chinspot Batis	Common	All major woodland types
706	*Stenostira scita*	Fairy Flycatcher	Common	A woody component is essential nearly all foraging occurs amongst woody plants. Intermittent scrub, riverine Acacia. Dense thorny tree or bush for nesting.
710	*Terpsiphone viridis*	Paradise Flycatcher*	Common	Woodland habitat, evergreen forests and broadleaved woodlands are preferred
711	*Motacilla aguimp*	African Pied Wagtail	Common	Margins, rocky patches and sandbanks of large rivers, pans, dams, estuaries and sewerage works.
712	*Motacilla clara*	Longtailed Wagtail	Common	Fast-flowing, well-wooded streams and rivers, large forested rivers, sometimes small quiet tributaries or streams in forests with pools and waterfalls,
713	*Motacilla capensis*	Cape Wagtail	Common	Adapted to urban and suburban habitats
716	*Anthus cinamomeus*	Grassveld Pipit	Common	Most grasslands, including open stretches round pans and in lightly wooded savanna, dry floodplains, avoids dense rank undergrowth
717	*Anthus similis*	Longbilled Pipit	Common	Slopes in relatively arid and eroded broken veld
718	*Anthus leucophrys*	Plainbacked Pipit	Common	Relatively mesic grasslands, edges of well-wooded country
720	*Anthus lineiventris*	Striped Pipit	Common	Broadleaved woodland on rocky outcrops and in gorges and along streams
723	*Anthus caffer*	Bushveld Pipit	Common	Bushveld savanna with some bare ground and some tree cover
727	*Macronyx capensis*	Orangethroated Longclaw	Common	Variety of grassveld types at fairly high elevations.
731	*Lanius minor*	Lesser Grey Shrike*	Common	Acacia thornveld, prefers arid open habitat
732	*Lanius collaris*	Fiscal Shrike	Common	Open spaces, exposed perches and short or sparse ground cover with trees

733	*Lanius collurio*	Redbacked Shrike*	Common	Medium dense thornveld
735	*Corvinella melanoleuca*	Longtailed Shrike	Common	Savanna and broadleaved woodland in the lowveld. Open savanna with short grass. Generally not adapted to man-made environments.
736	*Laniarius ferrugineus*	Southern Boubou	Common	Dense, tangled undergrowth and in thickets along watercourses and in a wide range of woodland types, also in gardens
737	*Laniarius aethiopicus*	Tropical Boubou	Common	Dense thickets in woodland
739	*Laniarius artococcineus*	Crimsonbreasted Shrike	Common	Acacia bushveld and woodland
740	*Dryoscopus cubla*	Puffback	Common	All types of indigenous woodland and forest, common in dense woodland
741	*Nilaus afer*	Brubru	Common	Wide variety of savanna woodland
743	*Tchagra australis*	Threestreaked Tchagra	Common	Woodland and scrub where it is limited to the undergrowth
744	*Tchagra senegala*	Blackcrowned Tchagra	Common	Wide range of scrub and woodland habitats and exotic timber plantations, only where there is dense undergrowth
748	*Telophorus sulfureopectus*	Orangebreasted Bush Shrike	Common	All types of woodland with a preference for mixed riparian woodlands
751	*Malaconotus blanchoti*	Greyheaded Bush Shrike	Common	Medium density woodland, less common in savanna and dense woodland
753	*Prionops plumatus*	White Helmetshrike	Common	Deciduous broadleaved woodland and a wider range of habitats in non-breeding season
756	*Eurocephalus anguitimens*	Whitecrowned Shrike	Common	Arid woodland. Trees for perching and nesting, forages in open areas with short ground cover. Not adapted to man-made environments.
761	*Cinnyricinclus leucogaster*	Plumcoloured Starling*	Common	Open woodlands
762	*Lamprotornis australis*	Burchell's Starling	Common	Savanna woodland, large trees and stretches of uncovered ground
764	*Lamprotornis nitens*	Glossy Starling	Common	Woodland species, but found in most vegetation types. Also plantations, and urban areas
765	*Lamprotornis chalybaeus*	Greater Blue-eared Starling	Common	deciduous broadleave or riverine woodland
769	*Onychognathus morio*	Redwinged Starling	Common	Cliffs and rocky areas, adapted to human habitat well
772	*Buphagus erythrorhynchus*	Redbilled Oxpecker	Common	Variety of woodlands, >400mm rainfall. Holes in trees for nesting. Needs wild or domestic ungulates as hosts.
774	*Promerops gurneyi*	Gurney's Sugarbird	Common	Montane scrub with Protea and Aloe, also gardens and Protea nurseries
775	*Nectarinia famosa*	Malachite Sunbird	Common	Fynbos, grassland, Karoo and open savanna. Often associated with scrubby hillsides and forest edge. Dependent on food plants (nectarivorous).
779	*Nectarinia mariquensis*	Marico Sunbird	Common	Acacia thornveld specialist
785	*Nectarinia afra*	Greater Doublecollared Sunbird	Common	Moist habitats with trees or tall scrub, does not frequent the interior of forests, preferring the edges and canopy. Coastal, montane and riverine scrub as well as Protea savanna, parks and gardens.
787	*Nectarinia talatala*	Whitebellied Sunbird	Common	Wide range of woodland and bush types

792	*Nectarinia amethystina*	Black Sunbird	Common	Predominantly broadleaved vegetation types, also gardens and plantations
796	*Zosterops pallidus*	Cape White-eye	Common	Catholic choice of habitat from scrub, through thicket to forest. Arid regions it associates with drainage lines
798	*Bubalornis niger*	Redbilled Buffalo Weaver	Common	Drier savannas preferred, especially Mopane. Heavily grazed woodland with sparse ground cover. Prefers large trees for nesting.
799	*Plocepasser mahali*	Whitebrowed Sparrowweaver	Common	Variety of vegetation types. Dry woodland and savanna areas preferred
801	*Passer domesticus*	House Sparrow	Common	Human dwellings
803	*Passer melanurus*	Cape Sparrow	Common	Relatively arid Karoo and grassland biomes. Prefers woody vegetation along drainage lines. Farms and urban areas
804	*Passer diffusus*	Greyheaded Sparrow	Common	Woodland habitat and in the grassland biome
805	*Petronia superciliaris*	Yellowthroated Sparrow	Common	Broadleaved woodland and savanna.
806	*Sporopipes squamifrons*	Scalyfeathered Finch	Common	Low, open thornbush, interspersed with grassy patches
810	*Ploceus ocularis*	Spectacled Weaver	Common	Tall woodland and other tall vegetation. Edge of forest and in riverine woodland and thickets
811	*Ploceus cucullatus*	Spottedbacked Weaver	Common	Near water in different woodland types along river valleys
813	*Ploceus capensis*	Cape Weaver	Common	Winter rainfall region and Fynbos biome. Prefers agricultural lands. In the Karoo and central interior frequents the cooler, wetter highlands. Nests in reeds or bulrushes along rivers and dams or in trees.
814	*Ploceus velatus*	Masked Weaver	Common	Open country most commonly inhabited, nest along watercourses in vegetation
815	*Ploceus intermedius*	Lesser Masked Weaver	Common	Open woodland and thornveld close to water
819	*Anaplectes rubriceps*	Redheaded Weaver	Common	Broadleaved vegetation in hot, moist areas
820	*Anomalospiza imberbis*	Cuckoo Finch	Common	Open grassland, open heavily vegetated vleis, and lightly wooded savanna.
821	*Quelea quelea*	Redbilled Quelea	Common	Most vegetation types (except the Fynbos). Woodland and grassland preferred
824	*Euplectes orix*	Red Bishop	Common	Grasslands near to water. Also areas cleared for cultivation
826	*Euplectes afer*	Golden Bishop	Common	Grassland, nest in tall grass in water
829	*Euplectes albonotatus*	Whitewinged Widow	Common	Woodland and grassland preferred, also the rank growth on the edges of grassy areas near water
831	*Euplectes ardens*	Redcollared Widow	Common	Mosaic of grass and bush
832	*Euplectes progne*	Longtailed Widow	Common	Open grassland habitat.
834	*Pytilia melba*	Melba Finch	Common	Acacia savanna, open grassland close to cover and mixed thorn and broadleaved savanna with thickets
840	*Lagonosticta rubricata*	Bluebilled Firefinch	Common	Moist wooded habitats

841	*Lagonosticta rhodopareia*	Jameson's Firefinch	Common	Open grassy areas with thickets in broadleaved woodlands
842	*Lagonosticta senegala*	Redbilled Firefinch	Common	Woodland. Savanna, riverine and thicket vegetation, particularly near water
844	*Uraeginthus angolensis*	Blue Waxbill	Common	Near surface water, virtually any non-forested habitat in the savanna areas
845	*Uraeginthus granatinus*	Violeteared Waxbill	Common	Shrubland in open Kalahari and Acacia woodland, also in open broadleaved woodland with thickets, particularly on deep Kalahari sands
846	*Estrilda astrild*	Common Waxbill	Common	Rank grasslands, reedbeds, croplands, coastal estuaries, inland wetlands and dams, gardens, sewerage works
847	*Estrilda erythronotos*	Blackcheeked Waxbill	Common	Thornbelt region near water
850	*Estrilda melanotis*	Swee Waxbill	Common	Habitat edges and transitional habitat. Edges of Afromontane or coastal forest, thick riverine scrub, grassy clearings in moist woodland and gardens.
852	*Ortygospiza atricollis*	Quail Finch	Common	Open areas of short grassland, floodplains, vleis and surrounding sedges. In drier areas grassland near to water is preferred
854	*Sporaeginthus subflavus*	Orangebreasted Waxbill	Common	Moist grasslands, grassy savanna, marshes, cultivated and fallow land
855	*Amadina fasciata*	Cutthroat Finch	Common	Drier broadleaved woodland and savanna types
856	*Amadina erythrocephala*	Redheaded Finch	Common	Dry open grassland areas with scattered trees or bushes
857	*Spermestes cucullatus*	Bronze Mannikin	Common	Edge habitat and dependent on water
860	*Vidua macroura*	Pintailed Whydah	Common	Wide range of open mesic habitats. Urban and cultivated areas
861	*Vidua regia*	Shafttailed Whydah	Common	Dry, grassy thorn and broadleaved savanna, scrub and woodland
862	*Vidua paradisaea*	Paradise Whydah	Common	Variety of semi-arid woodlands and savanna, principally thorn savanna
864	*Vidua funerea*	Black Widowfinch	Common	Edge habitats, prefers moist areas with forest-grassland ecotones
865	*Vidua purpurascens*	Purple Widowfinch	Common	Savannas and open broad-leaved woodlands.
867	*Vidua chalybeata*	Steelblue Widowfinch	Common	Thorn savanna, edges of broadleaved woodland and riverine scrub and woodland. Rural human settlements
869	*Serinus mozambicus*	Yelloweyed Canary	Common	Woodland habitat, in dry areas prefers habitat along river courses
870	*Serinus atrogularis*	Blackthroated Canary	Common	Dry country, including grassland, savanna and lightly wooded areas
878	*Serinus flaviventris*	Yellow Canary	Common	Wide variety of habitats, arid and semi-arid dwarf shrublands, arid savanna, alpine shrublands, dry grasslands and clearings at the edges of forests
881	*Serinus gularis*	Streakyheaded Canary	Common	Mountainous and hilly vegetation. Well-wooded regions preferred
884	*Emberiza flaviventris*	Goldenbreasted Bunting	Common	Open broadleaved and mixed woodland and savanna, gardens, farms, plantations
885	*Emberiza capensis*	Cape Bunting	Common	Variety of habitats and altitudes, from coastal strandveld to shrubland and grasslands of high mountains
886	*Emberiza tahapisi*	Rock Bunting	Common	Rocky ridges and hillsides, eroding stony slopes and gullies, and bare stony areas. Abandoned quarries and borrow pits

887	*Emberiza impetuani*	Larklike Bunting	Common	Arid and semi-arid savanna, sparse shrubland and grassland on rocky hills, particularly in sparse grassland on schists or tilted shales, sparse woodland and shrubland along drainage lines, arid sparse perennial grasslands with scattered shrubs, and dune g
888	*Milvus migrans parasitus*	Yellow billed Kite*	Common	A wide variety of habitat, mostly woodland especially with high levels of rural human habitation
889	*Milvus migrans migrans*	Black Kite*	Common	A wide variety of habitat, mostly woodland especially with high levels of rural human habitation
				A wide variety of habitats, preferring fairly open woodlands, often frequents rubbish dumps and sewerage works

CHAPTER 9
INTEGRATED DISCUSSION

9.1 Introduction

There are little other areas within South Africa with comparable attributes and potential for conservation like the Waterberg. Most other areas have constraints in one form or another. Most importantly the Waterberg is vast, unexplored and largely unknown, and should meet the growing needs of a certain sector of the tourism industry. A further advantage is that the Waterberg enjoys close proximity to the metropolitan area of Gauteng, there is no Malaria, and it has the capacity to develop an excellent infrastructure, which should cater for the needs of the discerning tourist (Walker, 2000). The vastness and new developments within the area further provide many opportunities for research in the ecological field and it was indeed the lack of ecological data on the vegetation, birds and mammals, and the many new tourism developments that initiated this project. The fact that ecotourism plays an increasingly important role as a tool to initiate conservation also contributed to the motivation behind this project. Both ecological aspects and aspects concerning ecotourist activities relating to ecology, were addressed and the one main conclusion was that the vegetation in the Biosphere Reserve should be considered as the basis of all further detailed ecological investigations within ecosystems and also for ecological management strategies. A summary of findings and conclusions drawn from the previous chapters are presented in the following section as an "Integrated Discussion" on the Waterberg Biosphere Reserve and its natural resources as tourist attractions.

9.2. Plant Community Classification

9.2.1 Methodological approach

The classification of the major plant communities in the Biosphere Reserve is the first comprehensive overview classification of the Waterberg vegetation. Although a plantecological survey was done by Coetzee *et al.* (1981) in the Kransberg area of the Waterberg, no such formal classification has been done, although some classifications were previously performed locally on smaller reserves and game farms in the main Waterberg basin.

The method used for classification was somewhat different to the method proposed by Bredenkamp & Bezuidenhout (1995) for large vegetation datasets. In the classification of the Waterberg plant communities, the main aim was to identify diversity of plant communities, rather than the phytosociological synthesis approach used by Winterbach (1998) in parts of the study area. The method could provide the basis for future studies aimed at identifying vegetation diversity over large areas of southern Africa.

The main criteria for using the old datasets were that all of the localities had to be visited and all plant communities had to be identifyable visually. If necessary, field surveys were performed in areas where plant communities could not be identified clearly as well as in areas where no data were available. This method was found extremely successful in the Waterberg Biosphere Reserve. However, a good knowledge of the area (e. g. geology, geomorphological features, climate, soil, vegetation patterns and topography) is necessary. Werger (1974) emphasized that this kind of knowledge is a prerequisite for successful phytosociological studies.

9.2.2 The Plant Communities

The multivariate numerical classification and subsequent refinement by Braun-Blanquet methodology (Bredenkamp & Bezuidenhout, 1995) revealed 12 major plant communities from 1897 relevés of various datasets, supplemented from own field surveys, indicating the high diversity in vegetation patterns over an area of 150 000 hectare. The plant communities of the Waterberg Biosphere Reserve showed a strong correlation with environmental factors (Bredenkamp & Brown, 2001) in the diverse landscapes. The factors determining the occurrence of the major plant communities were altitude, aspects, geology and soils, geomorphology and climate.

Different plant communities were identified and these communities could provide useful information to reserve managers in the Biosphere Reserve concerning veld condition, grazing capacity, types of animals, numbers of animals and general veld management practice (Bothma, 2000). An interesting aspect found from the field surveys done in the mountainous terrain of the Wonderkop Nature Reserve, is the definite difference from the Moist Mountain Bushveld in the other mountainous parts of the Waterberg. A new vegetation type could possibly be classified in future, as Waterberg Arid Mountain Bushveld on Waterberg Sandstone (Mogalakwena and Makgabeng formations) in this area, as similarly found by Siebert (2001) in Sekhukuneland. The absence of typical Waterberg species like *Diplorhynchus condylocarpon* and *Englerophytum magalismontanum*, and presence of typical sweet, arid grass species on the rocky slopes (Waterberg Sandstone) motivated the thinking behind such a classification.

The plant communities furthermore provide an indication of the diversity of the vegetation within the Biosphere Reserve on a large scale and could be used as part of an ecological management plan using the ecozones as basis, for the Biosphere Reserve. Furthermore, the communities provide to tourists interested in botany and to reserve managers a broad-scale plant species composition. The ecological management plans for smaller properties should however still be done at a local scale, as they will need more intensive management than the broad Biosphere Reserve.

9.3 Ecozones

9.3.1 Methodological approach

The ecozones in the Biosphere Reserve were identified in a similar way as Gertenbach (1983) had done for the landscapes of the Kruger National Park. Gertenbach (1983) classified a landscape as an area with a specific geomorphology, macroclimate, soil, vegetation pattern and associated fauna. Most of these parameters were used for the Waterberg Biosphere Reserve, although the associated fauna was rather linked to the ecozones after their habitat classification. Although some heterogeneity does occur in certain ecozones identified in the Biosphere Reserve (due to the complex topography), the most dominant abiotic components were grouped together as relatively homogenous units in a specific area, similar to Gertenbach (1987). The criteria for identification were therefore that at least two specific environmental parameters had to be dominant over the area (e. g. geological formations, vegetation pattern and geomorphological features in the *Diplorhynchus-Burkea* Rolling Mountains Ecozone). The scale at which the individual plant communities were identified made the mapping of plant communities almost impossible, but the ecozone (landscapes) "approach" enabled the mapping of ecozones as management units.

9.3.2 Ecozones as management units for the Biosphere Reserve

Bredenkamp & Van Rooyen (1991) noted that individual plant communities and/or ecological related groups of plant communities could be used for the delimitation of management units. Van Staden (in prep.) classified the landscapes of the Marakele National Park as management units. The 6 ecozones identified in the Waterberg Biosphere Reserve can be compared to these landscapes (on a larger scale) and could be used as part of a Biosphere Reserve management plan. The management plan could incorporate all owners of major conservation areas (e. g. nature reserves, national parks etc.) and ecotourist destinations, as well as smaller game farmers. The management plan should incorporate a system where owners co-operate to initiate large scale ecological management for the following aspects:

- Fire
- Monitoring of veld condition
- Roads
- Fencing
- Water
- Exotic problem plants
- Erosion control

Van Staden (in prep.) emphasized these as important aspects for a management program. Owners still have the option to perform their own management programs on their properties if they wish to do so, and the management of a larger area (for example a homogenous plant community occurring over more than one property) is only recommended to optimize management of the Biosphere Reserve. This large-scale management could be beneficial for maintaining veld condition, biodiversity and relations between landowners. However, co-operation between landowners and workshop presentations informing them of the benefits of such a management program, are extremely important.

The ecozones are considered to be specifically useful as management units for ecotourist activities, and providing tourists with useful information on the area and its attractions (e. g. geology, mammals, birds, aesthetic), in accordance to the tourism booklet of the Kruger National Park (Jacana, 1997).

9.4 Trees, mammals and birds as tourist attractions

9.4.1 Methodological approach

1.Trees:

The method used to rank the different tree and shrub species according to their combined tourism value (calculated according to certain attributes) and frequency abundance (reduced synoptic table) within the major plant communities is a completely new approach. The method is useful in providing reserve managers with information on the value of a specific tree and shrub species, within plant communities of the Biosphere Reserve.

2. Larger Mammals and birds

The classification of the mammal and bird habitats was done solely based on habitat preferences of species associated with the major plant communities identified. Fairbanks *et al.* (2001) and Reyers *et al.* (2002) used quarter degree grid data to classify avifauna distribution and diversity of specific areas. However, the classification for the bird and mammal communities of Biosphere Reserve was done somewhat differently. The data from quarter degree grids were combined to create bird and mammal species lists. This was done since the classification of the bird and mammal lists in the quarter degree grids was thought not to be representative of species distribution and communities in the Biosphere Reserve, since a quarter degree grid might represent a high diversity of animal habitats. Instead, the species lists associated with the plant communities according to habitat preferences were classified by TWINSPAN analysis to indicate specific habitat types within which mammal or bird communities occur. These habitat types are associated with the plant communities which form a mosaic of vegetation types in the ecozones (landscapes), giving a good indication of where certain mammal or bird species can be found.

9.4.2 Habitat types of mammals and birds

The habitat classification of the mammal and bird habitats gives a definite indication of specific animal communities that occur in different combinations of plant communities. Species groups in the synoptic tables should be interpreted as bird or mammal communities associated with specific habitat types, according to their habitat preferences. Bird communities seem to be more defined, since individual species have narrower specialized niche habitats (Wiens, 1989), while mammals have a much broader habitat preference, often dependant on the availability of grazing or browsing material (Skinner & Smithers, 1990) in the Sour Bushveld Veld Type (Acocks, 1988) of the Waterberg. Predators and raptors on the other hand, are more dependent on the availability of prey species. The diverse landscapes (ecozones) with its vegetation patterns create many diverse habitat types to birds and mammals, ranging from forests, low lying dense to open woodlands, rocky mountain slopes, grasslands and open water wetlands. Furthermore, the added habitat of the old fields plant community increases the diversity of mammals and birds even further. The old fields not only provide grazing to many mammal species, but also provide an added habitat to mammals (e. g. blesbok, springbok) and birds (e. g. crowned plover, korhaans) which would not normally occur in the mountainous areas. Brawn *et al.* (2001) concluded from a study that these so-called degraded land, accounting for 11.81% in the savanna ecoregion of South Africa (Reyers, 2002), plays an important role in diversifying avifauna habitats, and the same could be said for cultivated fields and other disturbed habitats outside conservation areas in the buffer zone of the Biosphere Reserve.

9.4.3 Vegetation Ecology: The basis for interpreting ecosystems

Species exist in natural settings, within functioning communities and ecosystems, interacting with other species and the abiotic environment (Meffe & Carroll, 1997). It is fundamental that vegetation is always an integral part of an ecosystem and can only be studied by fully exploring its role within that system. In terrestrial ecosystems, vegetation supports the entire ecosystem by fixing light energy in manufacturing the organic food needed for energy flow through the system (Bredenkamp & Brown, 2001). In this study, it became clear that the vegetation of the Waterberg Biosphere Reserve plays an integral part in the functioning of the ecosystems, providing habitats to birds and mammal species and forming mosaics within landscapes (ecozones). The plant community may also serve as basis for ecological management plans (Bredenkamp & Brown, 2001) of locations in the Waterberg, although this aspect was not addressed in the study.

Vegetation structure seems to play an overwhelming role in providing animal species with shelter, nesting sites and food. The habitat preference of mammals and birds is often described as a specific vegetation structure, e. g. open woodland, short open grasslands etc. The different plant communities identified in the Waterberg all possessed a very distinct structure as classified by Edwards (1983). Therefore linking the mammals and bird habitat preferences with the distinct plant communities was relatively easy. However, the individual plant species composition of plant communities will also determine the grazing- and browsing capacity for mammal species, and the amount of food available to seed - and fruit-eating bird species.

The ecosystem of the Waterberg Biosphere Reserve and components thereof functioning as tourist attractions, can be interpreted as follows as shown in Figure 9.1:

- The 12 major plant communities identified, as the basis of ecosystems, form the habitat types for bird (7 habitats) and mammal species (5 habitats) present in the area as tourist attractions (e. g. game-viewing, bird watching activities).
- These plant communities have a certain plant species composition, of which there is a woody component (e. g. trees and shrubs as tourist attraction; browsing) and a herbaceous component (grasses, forbs as browsing / grazing).
- Different combinations of plant communities form part of specific ecozones (6 ecozones or landscapes) representing larger ecosystems, which possess aesthetic

value, but also have the function as management units for a possible broad-scale management plan.

9.4.4 Natural resource ecotourist attractions in the Waterberg Biosphere reserve

The savanna region is the core of wildlife and ecotourism (Bredenkamp, 2002[a]), and the many ecotourist destinations such as Lapalala Wilderness, Entabeni Game Reserve, Shamabala Private Nature Reserve (Fig. 9.2), Welgevonden Game Reserve and Marakele National Park in the Waterberg Biosphere Reserve, provide tourists with the opportunity to explore the area with its diverse natural resource attractions. Some of these ecotourist destinations provide more for overseas visitors (e. g. Entabeni Game Reserve, Welgevonden Game Reserve) and corporate guests (e.g. many private lodges in the Welgevonden Nature Reserve and Shambala Private Nature Reserve have conference facilities), while others aim at the local market (e. g. Marakele National Park, Jobedi Game Lodge). The number of overseas visitors will largely depend on the presence of high profile species like members of the "big five" (lion, elephant, buffalo, rhinoceros and leopard), while smaller reserves like the Nylsvley Nature Reserve attract many local birders. Meffe & Carrol (1997) stated that natural sites supporting high profile species, or ecosystems with obvious public appeal are suitable for ecotourism and considering the presence of the "big five" and other larger mammal species, more than 400 bird species (including the largest colony of cape vultures in the world), diverse vegetation and aesthetic value of the mountainous regions, the potential of ecotourism in the Biosphere reserve is tremendous, although still being in a growing phase. The ecotourist destinations provide many activities to attract tourists, like game drives (night or day), walking safaris, fourwheel-drive safaris and many more. Considering that other aspects of the ecosystem, like reptiles and insects have not been included as possible tourist attractions, the potential for ecotourism in the Waterberg could be even higher.

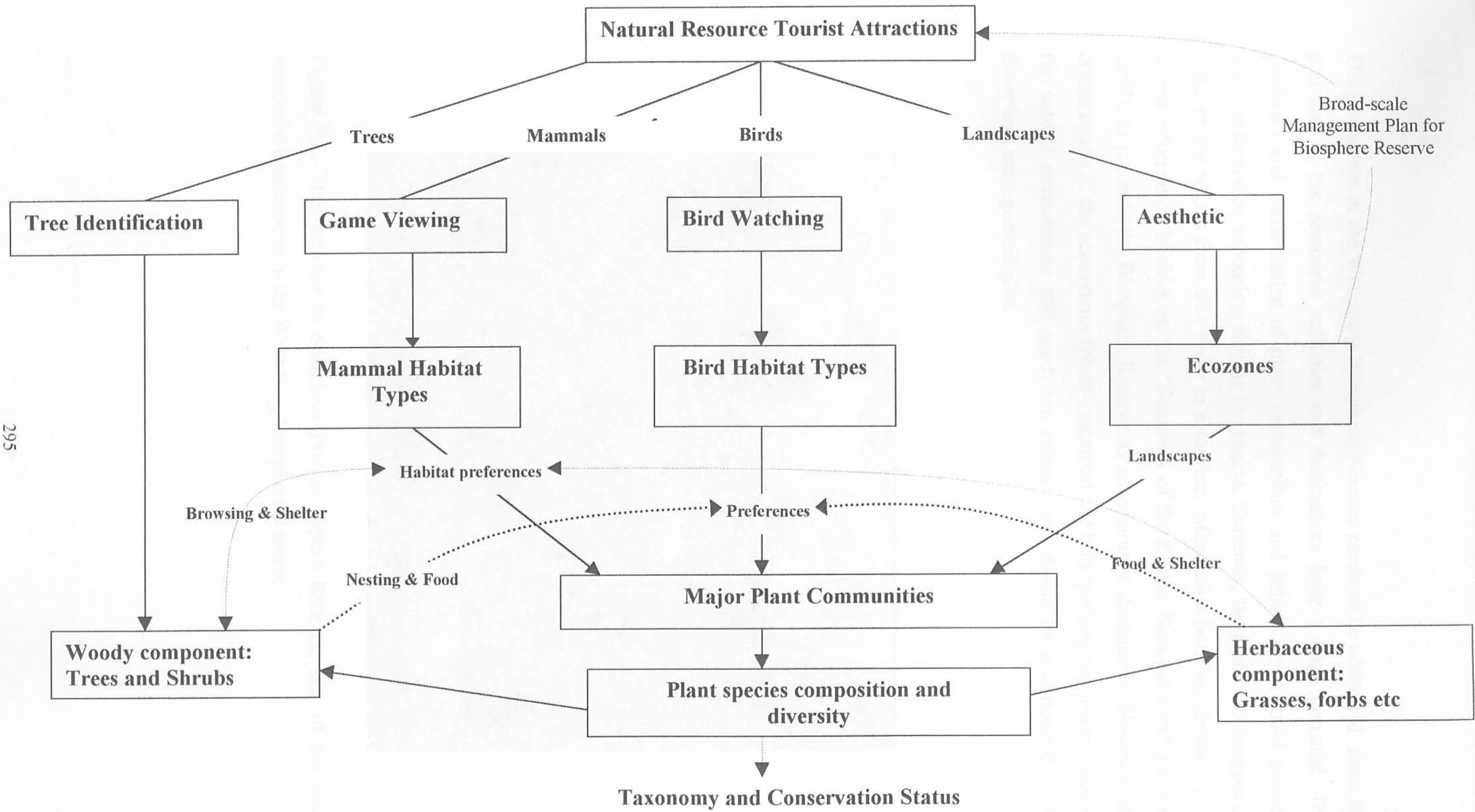

Figure 9.1 Tourist attactions of the Waterberg Biosphere Reserve and their ecosystem functions

The promotion of the Waterberg Biosphere Reserve needs to be addressed, since the potential of the ecotourist activities and destinations have a huge potential. The databases and classification of plant communities and habitat types could provide useful information to tourists visiting the region. Currently, the plan is to incorporate some of the results from this study in a tourism information booklet, similar to the tourist information booklet on the "Ecozones of the Kruger National Park" (Jacana, 1997), to promote the Biosphere Reserve as an ecotourist destination. However, the conservation of the ecosystems (plant-, mammal and bird species) and preservation of the natural environment still needs top priority and should be incorporated in the Biosphere management plan.

Figure 9.2. The entrance to Shambala Private Nature Reserve, one of the many ecotourist destinations in the Waterberg Biosphere Reserve

9.5 Ecotourism within the Waterberg Biosphere Reserve and its importance for conservation and sustainable development

Meffe & Carroll (1997) noted that nature tourism have many benefits such as ecosystem preservation, biodiversity conservation, education and research. The Waterberg Biosphere Reserve, with its many ecotourist destinations and great diversity (e. g. mammals, birds, plants) plays an important role in conservation, but also as an important source of public education [for example the outdoor classrooms at Lapalala Wilderness where more than 40 000 teachers and children passed through over the past 19 years (Walker, 2000)] and research. Although Isaacs (2000) describes ecotourism as a viable economic activity that can minimize negative human impacts on wildlife habitat and provide an incentive to protect natural areas, ecotourism is still unable to ensure long-term protection of species. He further noted that in certain aspects, the promotion of ecotourism might actually distract from more appropriate means of environmental protection. Therefore, the importance to have a proper management plan in place for the Biosphere Reserve cannot be over-emphasized. Management strategies should implement both ecological management plans and ecotourism management strategies. Klein *et al.* (1995) suggested that ecotourism should be held at acceptable levels and refuge managers should know which species are likely to be affected and which response occurs at different levels of disturbance. The importance of public education and changes in management practices was identified to reduce disturbance of waterbirds in Florida (U. S. A). Guided tours and low disturbance zones were identified as possible strategies to eliminate negative tourism impacts. To implement such management plans in the Biosphere Reserve, a thorough knowledge of the ecosystems of the area on a local, community and landscape level is essential.

The many rare and endangered bird and mammal species of the Waterberg Biosphere Reserve as tourist attractions, listed in the red data list (Hilton-Taylor, 2000), should definitely be prioritized as part of a conservation strategy. Furthermore, although the rare and endangered plant species have not been included in the study, the implementation of proper ecological management plans for the identified plant communities need to be implemented to ensure ecosystem preservation. The general conservation status of the bird, mammal and plant taxonomic groups in different ecoregions of South Africa, represented in the Biosphere Reserve, is included in Table 9.1. The ecoregions are represented in the following areas of the Waterberg Biosphere Reserve:

- Grassland Ecoregion: High Altitude Grasslands on the escarpment crest in Marakele National Park (>1800m)
- Forest Ecoregion: Kloofs, ravines and gorges in the Afromontane region of the escarpment in Marakele National Park and Entabeni Game Reserve
- Freshwater Ecoregion: Dams, pans, rivers, wetlands or any other water associated area within the Biosphere Reserve (e. g. Nylsvley Nature Reserve, Entabeni Game Reserve, Emaweni Game Lodge etc.)
- Savanna Ecoregion: All regions other than the areas described above

The authors referred to in Table 9.1 were the main contributors of information on the different taxonomic groups of organisms and the data were adapted from the information booklet on "The Biodiversity of South Africa 2002: Indicators, trends and Human Impacts". Although not all the species referred to in Table 9.1 are presented in the ecoregions of the Biosphere Reserve, it gives a good indication of the importance of conservation of sensitive areas within the ecoregions. Reyers *et al.* (2002) noted that existing complementary-based reserve selection techniques concerned with maximal biodiversity representation within minimum land-area do not necessary ensure long-term maintenance of biodiversity. However, the 150 000 hectares of land included in the Waterberg Biosphere Reserve, which include several conservation areas, represent most of the diversity that occurs throughout the area based on the diversity in plant communities, habitat types and ecozones (landscapes) identified within the Biosphere Reserve. This enhances the conservation of bird, mammal and plant species in the different ecoregions represented within the conservation areas.

Although conservation of natural resources within conservation areas of the Waterberg Biosphere Reserve needs top priority, local participation as part of sustainable development and ecotourism also needs to be implemented. Community initiatives such as the community participation program in the Wonderkop Nature Reserve, and the Masebe Nature Reserve as a communal (tribal) reserve within the

Biosphere Reserve are excellent examples of sustainable development. Other areas in the Biosphere Reserve, which could be included in such developments, include the Sterkrivier community and local communities of Thabazimbi and Vaalwater. Kellert (1986) stressed the importance of adequate public understanding of the values derived from the land protection in Biosphere Reserves, and ample opportunities of job creation, upliftment and resource development within the Waterberg Biosphere Reserve exist. Considering the statement by Homewood & Brockington (1999) that the conservation of an area relies increasingly on reserve-adjacent people, and on prioritizing the allocation of scarce resources, the Waterberg area, being rather unpopulated, is in the privileged position to provide for both the local communities, while conservation still receive top priority.

Table 9.1 Ecoregions of South Africa represented within the Biosphere Reserve and conservation status of mammals, birds and plants within them

	No. Species	No. Endemic Species	% Endemism	Critical	Endangered	Vulnerable
Savanna Ecoregion (Bredenkamp, 2002[a])						
Mammals (JH)	167	6	15%	2	2	9
Birds (JH)	532	8	15%	1	2	26
Plants (GB)	>5700	?	?	?	?	?
Grassland Ecoregion (Bredenkamp, 2002[b])						
Mammals (JH)	89	18	44%	0	1	8
Birds (JH)	349	31	58%	5	3	17
Plants (GB)	>3370	?	?	?	?	?
Forest Ecoregion (Lawes, 1992)						
Mammals (JH)	53	10	24%	0	2	7
Birds (JH)	122	12	23%	0	2	4
Woody Plants (CG)	474	130	27.4%	0	2	7
Freshwater Ecoregion (Cambray, 2002)						
Mammals (JH)	15	0	0%	0	0	1
Birds (JH)	139	2	4%	3	1	6

JH - James Harrison; GB - George Bredenkamp; CG - Coert Geldenhuys

9.6 The Way forward

The study provided information on several ecological and tourism concepts. However, the opportunities for other research projects to flow from the project are a definite possibility. Batisse (1982) noted that the direct involvement of the local population in the management of Biosphere Reserves, together with the maintenance of research and monitoring activities in them, constitute the best guarantee for long-term conservation of genetic resources on a world-wide basis. Currently other research projects being done in the Biosphere Reserve include a project on the financial viability of tourism initiatives and other developments in the Biosphere Reserve, while another involves research on the participation of the local communities in the Biosphere Reserve as part of ecotourism. It is strongly recommended that a research team be formed in the Waterberg Biosphere Reserve to promote the Waterberg as a tourist destination, but also to ensure the preservation of its unspoiled status.

Definite opportunities sprouting from the study in the ecological field includes a syntaxonomic synthesis on the Mountain Bushveld of the Waterberg. This will not include the relevés of plant communities like wetlands and old fields as used in the study, but would be a formal detailed classification of the natural areas underlain by Waterberg Sandstone in the main Waterberg basin. Areas (e. g. Wonderkop Nature Reserve, Moepel Farms) where no information on the ecology (e. g. vegetation, ecosystems etc.) is available should be surveyed, to expand on the current database. Monitoring research programs on threatened plants, mammals and birds on reserves in the Biosphere Reserve could form an important part of conservation programs in the future. This plays an important role in preventing species loss, especially considering endemic plant species (e. g. *Vitex pooara, Combretum nelsonii*). Reyers (2002) suggested the following actions to curb the ebb of species loss in South Africa as management strategies:

- Integrate the protection and management of biodiversity resources and abiotic processes with all human development by means of regional and national conservation initiatives. Biosphere Reserves play an integral part in this aspect, and future planning of such areas in South Africa (e. g. Blyde-Kruger Canyons initiative) could promote the conservation of biodiversity even further.

- Build on existing programs to undertake biodiversity assessments and identify ecosystems, species and genetic resources that are at imminent risk of extinction. A proper ecological management plan implemented by the Waterberg Nature Conservancy, in conjunction with Limpopo Nature Conservation and Department of Environmental Affairs should be implemented.
- Initiate appropriate action to alleviate potential threats and develop early-warning systems. This aspect involves research monitoring programs on threatened species as mentioned above.
- Accelerate taxonomic knowledge of new species and genetic resources; and verify existing knowledge. The study forms the basis for specific in-depth studies on specific aspects named above could be done in future. The current study provides the basis on most updated existing knowledge.
- Build capacity in the area of threat assessment, taxonomy, technology development, knowledge transfer and appropriate technology. The ecotourism industry could play an important role in these aspects in the future, and other research projects could be initiated from them.

The opportunities for research and monitoring projects in the Biosphere Reserve are huge, especially considering the ecotourism potential of the area. However, the Waterberg cannot compare with the tourism "hotspots" of South Africa (e. g. Cape Town, Kruger National Park) and it should not attempt to do so, but should retain its own unique blend of wild country with its multi-cultural diversity catering for budget as well as international tourists.

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SUMMARY

The relevance of ecosystems to ecotourism in the Waterberg Biosphere Reserve

by

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The Waterberg area, Limpopo Province, South Africa, holds great potential as an ecotourist destination, especially considering the many conservation areas within the area. The promotion of these ecotourist destinations within the area can therefore not be underestimated. The newly declared Waterberg Biosphere Reserve has many conservation areas, preserving a high diversity of natural resources. The Reserve plays an important role in conservation and sustainable development. This study was performed to identify different aspects of ecosystems, which can enhance the potential of ecotourism within the area.

Twelve major plant communities were identified within the Biosphere Reserve. These plant communities formed the basis from which other analyses were performed, emphasizing the value of vegetation science in environmental planning and analysis. Tree and shrub species were analyzed as ecotourist attractions within the plant communities according to specific attributes they possess (e. g. medicinal, food source, uses). Six ecozones were identified as a mosaic of different plant communities within a homogenous landscape, and it is suggested that they should be incorporated as ecological management units as part of an ecological management plan for the Biosphere Reserve. These ecozones each include specific mammal or bird habitat types, of which the plant communities formed the basis for their identification. The vegetation structure and species composition of plant communities will often determine which mammal or bird species tourists can view while participating in ecotourist activities. The importance to conserve these habitats, especially of species

listed as threatened species on the red data list, and the importance of monitoring projects for such species are emphasized in the study.

A tourism booklet providing tourists with information on the tourist attractions and ecotourist destinations within the Biosphere Reserve is planned, to promote the area as a tourist destination in the future. The study also provides the basis for many possible research projects in the ecological and ecotourism fields in the future.

CURRICULUM VITAE

Barend Johannes Henning was born on 6 September 1976 in Pretoria, Gauteng. He attended Secunda Primary School in Secunda, Mpumalanga, and later Akasia High School in Pretoria, Gauteng, where he matriculated in 1994.

In 1995 he enrolled at the University of Pretoria, and was awarded his B.Sc. degree in 1997, with Entomology and Botany his majors. In 1998 he registered for an Honours degree in Botany at the same university and specialized in mycology. He obtained his degree at the end of that year. The following year (1999) he registered for his Masters degree in Botany at the same university, specializing in the field of soil science and agriculture. He completed his dissertation in 2000 entitled "The agricultural recycling of sewage sludge for maize and oats cultivation".

However, it was his dedication towards nature that motivated him to register for a Doctoral of Philosophy Degree, specializing in plant ecology, at the same university in 2001. He completed the dissertation entitled "The relevance of ecosystems to ecotourism in the Waterberg Biosphere Reserve" in 2002. His work was presented at a local and international conference. A popular tourism booklet and several publications are being planned for future publication.

He is currently working as a free-lance tourist guide throughout South Africa, and plans to work for a period of two years at a private game reserve in the lowveld, Mpumalanga as a ranger guide, after which he plans to start a tourism business venture.