Biodiversity and Ecology of Critically Endangered, Rûens Silcrete Renosterveld in the Buffeljagsrivier area, Swellendam

by
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Declaration

I hereby declare that the work contained in this thesis, for the degree of Master of Science in Conservation Ecology, is my own work that have not been previously published in full or in part at any other University. All work that are not my own, are acknowledge in the thesis.

_____ Date: _____

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Summary

Rûens Silcrete Renosterveld (RSR) is a critically endangered vegetation type in the Overberg region of the Western Cape Province of South Africa. In the last few centuries about 80% of it has been severely transformed by agriculture. The RSR contains many unique and rare plants species, and has very high conservation value. It is recommended that all remaining areas of this vegetation type should be conserved. However, very few of these areas are formally conserved and most are on farms where they are used for grazing of domestic livestock. The RSR appears to be sensitive to overgrazing and to grazing at a time of the year when it is sensitive to major change. This study examined the effects different grazing regimes had on the RSR vegetation on farms in Buffeljagsrivier, a small farming community in the Eastern Overberg. Different methods were used to compare vegetation structure and composition, of heavily-, medium- and under-grazed areas.

Information on the biodiversity in RSR areas was found to be scarce, with almost nothing known of the invertebrates. In this study a comprehensive checklist of plants and vertebrates in the study area was compiled. An insect order/family list and separate species lists of Lepidoptera and Orthoptera were also compiled. The insects were recorded by using different collecting and observation methods. A study was also made of the major plant/animal interactions occurring in the area. For this study, the focus was mainly on interactions with two dominant woody plants, *Acacia karroo* and *Searsia glauca*. Other interactions were also noted.

Different grazing regimes affected both structure and plant composition in the different grazing camps. Some plant species were found to be more dominant in heavily-grazed areas and some more in under-grazed areas. Heterogeneity in grazing pressure of the camps contributes to make the whole area more diverse and may have enabled the high biodiversity to persist in the area.

More than 400 indigenous plant species were recorded in the study area of which more than 30 plant species were found to be of conservation concern. 37 % of the overall species are endemic to the Cape Floristic Region. The study area contained 127 geophyte species. This is 51 % of all the known geophyte species that occur in the Langeberg Centre. A new plant species, *Haworthia groenewaldii*, was discovered in the study area. Overall, 214 insect families in 23 insect orders were also found in the study area. A total of 103 Lepidoptera species was recorded. About five moth species are possibly new to science and still need to

be scientifically described. Some plants and insects were recorded beyond their known geographical ranges. Twelve different frog, 22 reptile, 30 mammal and 122 bird species were found to occur in the study area.

Nineteen insect species from 14 insect families in four orders associated with *Acacia karroo* trees were found in the study area. Thirty-four insect species from 25 families, in six orders, were found to be interacting with *Searsia glauca* trees. Sixty one bird species were associated with *A. karroo* and 42 with *S. glauca*. Other interactions that were observed included caterpillars feeding on host plants. For the Lepidoptera list, the possible plant species on which the juveniles feed was also investigated.

This study unequivocally showed that this geographical area has a very high overall biodiversity that needs to be conserved. It also found that grazing can affect the composition distribution and combination of this biodiversity. Much research is still to be done on plant/invertebrate interactions in the RSR. This study provides a baseline for further research on future actions to conserve this unusual and special area in terms of invertebrate biodiversity especially for generations to come.

Opsomming

Rûens Silkreet Renosterveld (RSR) is ’n Kritiek Bedreigde veld soort,in die Overbergstreek van die Wes-Kaap Provinsie van Suid-Afrika. Omtrent 80% van RSR is uitgeroei deur landbouprakteike van die afgelopetwee eeue. RSR bevat baie unieke en skaars plant spesies en het dus ’n baie hoë bewaringswaarde. Dit word aanbeveel dat alle gebiede wat die tipe plantegroei bevat, bewaar behoort te word.

Baie min van die oorblywende RSR word formeel beskerm en die grootste gedeeltes wat nog oor is, kom voor op plase waar dit vir weiding ingespan word. Die veld soort is skynbaarbaie sensitief vir oorbeweiding, asook vir beweiding in die verkeerde seisoen.

Hierdie studie het na die uitwerking van verskillende weidingsmetodes op natuurlike veld op aangrensende plase in Buffeljagsrivier, ’n klein plaasgemeenskap in die Oostlike Overberg, gekyk. Verskillende metodes was gebruik om die plantegroei se samestelling en struktuur van ’n lae, middelmatige en oorbeweide gebiede met mekaar te vergelyk.

Inligting oor die biodiversiteit van RSR, veral oor invertebrate, was moeilik om in die hande te kry. Spesies lyste so volledig as moontlik was in die studie vir al die vertebrate en plante opgestel. Lyste is ook opgestel vir alle insek ordes en families, wat in die studiegebied versamel is. Daar is ook aparte lyste opgestel vir alle Lepidoptera en Orthoptera, in die studiegebied. Verskillende metodes was gebruik om insekte te versamel en te monitor. Die interaksies tussen plante en diere, wat voorkom in die studie gebied, is ook bestudeer Twee plantsoorte, *Acacia karroo* en *Searsia glauca*, is uitgesonder en so veel moontlik biologiese interaksies is opgeteken. Ander interaksies was ook aangeteken soos hulle in die veld aangetref is.

Die studiegebied het meer as 400 plant spesiesbevat. Van die was meer as dertig van bewaringsbelang. Sewe-en-dertig persent van die plante wat aangeteken is, is endemies tot die Kaapse Plant Koningryk. Daar is altesaam 127 bolplant spesies gevind wat net meer as die helfte van alle bolplant species wat vir die Langeberg Kern aangeteken is. *Haworthia groenewaldii* is ’n nuwe plant spesies wat in die studie gebied ontdek is.

In die studie area is 214 insek families in 23 insek ordes opgeteken. Van die is 103 Lepidoptera species (waarvan vyf moontlike nuwe spesies is) aangeteken in die studiegebied.

Negentien insek spesies van 14 insek families in vier ordes het interaksies met *A. karroo* getoon. Interaksies tussen vier-en-dertig insek spesies van 25 insek families in sesordes het met *S. glauca* getoon Een-en-sestig voël spesies was geassosieerd met *A. karroo* en 42 met *S. glauca*. Ander interaksies watgewaar is, sluit ruspes op voedselplante in.

Twaalf verskillende paddas, 22 soorte reptiele, 30 soorte soögdiere en 122 soorte voëls was ook in die studie gebied aangeteken.

Uit die huidige studie is dit duidelik dat die gebied ŉ baie hoë biodiversiteit besit wat beskerm moet word. Daar is ook bevind dat weiding die samestelling en struktuur van RSR kan beïnvloed. Verdere studies oor die plant/dier interaksies in RSR behoort gedoen te word en hopelik dien die huidige studie as ŉbegin vir verdere navorsing oor hoe ons die unieke veld soort vir die nageslag kan bewaar.

Layout of the chapters

Chapter 1: Literature review, with description of study area and sites

Chapter 2: This chapter will focus on the plant biodiversity of the study area as well as the effect that different grazing regimes have on the structure and composition of the RSR of the study area.

Chapter 3: This chapter will focus on the non-plant biodiversity of the study area, as well as the interaction between them and plants.

Chapter 4: This chapter will give the final conclusions for the study as well as some recommendations.

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Chapter 1: Introduction and study area description

1.1 Rûens Silcrete Renosterveld as a component of the Cape Floristic Region

The Cape Floristic Region (CFR) is well known for its rich plant diversity (Kemper *et al*. 1999). It is known as one of the 25 biodiversity hotspots of the world (Myers et al, 2000). The CFR comprises an area of about 90000 km^2, <4% of the total area of southern Africa, and yet it is estimated to support 9 600 vascular plant species (Goldblatt, 1978). Of these plants, 70% are endemic to the region. The rich plant diversity of the CFR is well known and most vegetation types have been well studied (Mucina & Rutherford 2006). The CFR can be divided into three main vegetation types: Fynbos, Renosterveld and Strandveld (Manning, 2007). Other vegetation types that also occur in the Western Cape are Succulent Karoo and thickets (Goldblatt & Manning, 2000). Fynbos is known as an evergreen, hard-leaved shrubland that occurs on poor soils derived from sandstone or limestone (Manning, 2007). It mostly occurs on the Cape Fold Mountains of the Western Cape. Fire is one the key drivers for Fynbos as it puts nutrients into the soil and prevents the Fynbos from turning into thicket/forest. Many of Fynbos plants are serotinous, that is, they only release their seeds following the aftermath of fire, and also often after fire has killed the adult plants.

Strandveld is found on the coast and establishes on more alkaline soils that are nutrient rich. The vegetation consists of broad-leaved plants that are less susceptible to fire than Fynbos. Many of the plants bear fruit and are dispersed by birds. In turn, Renosterveld consists of a vegetation type that is either dominated by small-leaved shrubs (mainly *Dicerothamnus rhinocerotis*) or by grasses like *Themeda triandra* (McDowell &Moll, 1992; Raitt, 2005). It also has very high geophyte diversity. The two common Fynbos families, Ericaceae and Proteaceae, tend to be absent from Renosterveld (Rebelo *et al*., 2006). Like Fynbos, Renosterveld also tends to be driven by fire (van Wilgen *et al*., 1992) and some researchers suggest that it has a shorter fire interval than Fynbos (Raitt, 2005).

Of these three vegetation types, Renosterveld, especially in the southern Cape, is the least studied. Renosterveld is also the most endangered of the three, as it occurs on more fertile soils (Goldblatt & Manning, 2000) and this makes it more prone to be used for agriculture (McDowell & Moll, 1992), with much of the original vegetation already cleared (Rebelo & Siegfried, 1992). The remaining fragments of Renosterveld are those that are often too steep or rocky to be ploughed (Cowling *et al*, 1986). Remnant Renosterveld patches are usually used for grazing where they occur on livestock farms. Inappropriate management of the

Renosterveld remnants has encouraged domination by unpalatable shrubs and grasses, and has also led to erosion. This has had a negative effect on the unique biodiversity of the Renosterveld patches and has also lowered the grazing value of this natural veld to the farmer (Cowling *et al*., 1986; Kemper *et al*. 1999; Raitt, 2005).

One of Renosterveld subtypes is the Rûens Silcrete Renosterveld (RSR) (Mucina & Rutherford 2006), which is the focus of study for this thesis. At a regional scale, the vegetation in this area is known as South Coast Renosterveld (Acocks, 1979). It is a small-leaved scrubland with a dominant grass element (Cowling *et al*, 1986). South Coast Renosterveld is known to be grassier than the West Coast form (Cowling *et al*, 1986), and includes the RSR. The RSR is particularly common along the lower Breëde River south of Buffeljagsrivier to Malgas (Mucina & Rutherford, 2006). The RSR is a critically endangered vegetation type, as 78% of it has been transformed into agricultural land (Mucina & Rutherford, 2006). Furthermore, the RSR contains rare and endemic plants that are sensitive to grazing and trampling, and a preservation approach has been recommended (De Villiers *et al*. 2005). However, still little is known of the biota of the RSR, a situation which I attempt to address here.

1.2 Main ecological drivers

1.2.1 Grazing

Historically, the vegetation of the RSR has been known as sweet grassland which supported large populations of large and medium game species such as Cape buffalo (*Syncerus caffer*) and Bontebok (*Damaliscus pygargus* spp. *pygargus*). Evidence of the occurrence of these animals in the area is seen in the names of old farms like Bontebokskloof and Buffeljagsrivier (Tomlison, 1943). Cowling (1986) argues that much of the Renosterveld on the South Coast of South Africa has been derived from *T. triandra*-dominated (Rooigras) grassland. Raitt (2005) has studied *T. triandra*-dominated Renosterveld adjacent to the Langeberg Mountains in the Eastern Overberg, and provides important background for the study here.

The area was also used historically by Khoi as natural pastures for their longhorn cattle and fat-tail sheep (Tomlison, 1943; Krug, 2004; Raitt, 2005). As they did not use fences, the veld would not have been overgrazed as it is today. The Khoi herders would have moved on to other areas when the veld was grazed short (Krug, 2004). This changed with the arrival of

Europeans to the area. The large mammals were hunted to extinction, and the Khoi were also driven out (Tomlison, 1943; Skead, 1980). The European settlers then developed the area and started agricultural production, which involved fencing the veld, and subsequently leading to overgrazing. Constant heavy grazing has turned the grassland into shrub-dominated veld (Krug, 2004; Raitt, 2005) as a result of the selective grazing of palatable plant species by domestic stock. Plants like Renosterbos (*Dicerothamnus rhinocerotis*), Steekbos (*Cliffortia ruscifolia*) and other unpalatable plants, especially Asteraceae like *Oedera* and *Muraltia*, have become the dominant plants in the area (Raitt, 2005). Some areas were also fenced off to prevent grazing, which in turn, led to the loss of Rooigras, and the formation of thickets dominated by *Acacia karroo*, *Searsia* species and *Asparagus* species.

1.2.2 Fire

Fire has played a major role in maintaining the grassy component of the area, with the absence of fire leading to the formation of thickets (Krug, 2004; Rait, 2005). Fire prevents woody shrubs from out-competing the grasses. It is thought that the Khoi may have used fire in the past to promote grasses and edible geophytes (Krug, 2004). *Cliffortia ruscifolia* is a plant that spread as a result of overgrazing and/or the absence of fire in the area (Raitt, 2005).

Fire in an inappropriate season can have a damaging effect on the grass component of the area, and may even lead to dominance of unwanted plants (Krug, 2004; van Wilgen *et al*., 1992). Veld should not be burned in the wetter times of year, as it is the time when grasses are flowering and producing seeds (Rait, 2005). This can be detrimental for the grasses in two ways. Firstly, they lose that season's seeds that could have produced more plants. Secondly, the plants may not re-sprout after the fire, with all the plant's reserves having gone into producing flowers and seeds. In the dry season, grasses store nutrients in their roots, and the fire only burns away the dead, above-ground parts.

1.2.3 Ploughing

Ploughing has resulted that only 20% of the original extent of RSR remains today (Mucina & Rutherford, 2006). If a previously ploughed area of the RSR is left to natural succession for a few years, weedy grasses like *Melinis repens* start to dominate the area (Figure 1.1; Plate 1.1). *Melinis repens* is known to be a pioneer grass in disturbed areas (Van Oudtshoorn, 2006) and can sometimes be found growing next to roads, although help to stabilise disturbed areas.

Melinis repens -dominated areas are used for grazing, although its leaf production is not high (Van Oudtshoorn, 2006). Over time, grasses better suited to grazing, like *Hyparrhenia hirta*, and *Eragrostis curvula* may start to grow in these areas. *Themeda triandra* does not seem to return to these heavily disturbed areas (Raitt, 2005). If these cultivated areas are grazed too intensively, larger, unpalatable shrubs like *Cliffortia ruscifolia* may start to invade (Figure 1.2; Plate 1.1).

1.3 Conservation value

The RSR was never common in the landscape, and only around 20% of it is left (Mucina & Rutherford, 2006). The RSR has very high conservation value as it has high plant diversity that contains many rare and endangered plants species. Some of these plants are found nowhere else but in the RSR. In some areas, the RSR patches are the only natural vegetation left within a matrix of cultivated land. These islands may also support many other organisms which are absent from the surrounding farmland. The RSR also contains many insect species, some of which have not yet been described. Given this level of irreplaceability, it is thus important to conserve and manage as much of the RSR patches as possible.

1.4 Focal study area and sites

1.4.1 Buffelsjagsrivier

This study focused on the area near Buffeljagsrivier (Figure 1.3; Plate 1.2), a small village on coastal plain between the Langeberg Mountain range in the north and the Indian Ocean in the south in the Western Cape Province, South Africa. This area is also known as the Eastern Overberg or Eastern Rûens. It is situated at the lower reaches of the Buffeljagsrivier as well as next to the Breede River. Swellendam is the nearest town (±10 km) to Buffeljagsrivier.

Fruit orchards cover much of this area, followed by planted pastures for grazing dairy cattle. Stone fruit, like peaches and plums, are the main crop, followed by citrus and apples. The largest persimmon farm in southern Africa is also situated in the area on the river terraces and in the hills above the valley. The rest of the higher-lying areas are used for grazing by cattle/sheep or are not used for any agricultural purposes. Some of these non-production areas were ploughed in the past, while others remain in their original state.

Farmers have used the RSR for grazing, and this had led to its deterioration in the past. Large areas had lost the dominant grassy components even when first Europeans moved through the area (Skead, 1980; Krug, 2004; Raitt, 2005), and such areas are overgrown by unpalatable shrubs like *D. rhinocerotis* (Renosterbos) and *C. ruscifolia* (Steekbos), and hard, unpalatable grasses like *Merxmuellera disticha* (Bergkoperdraad).

1.4.2 Location of study sites

Mullersrus is one of the two larger districts of Buffeljagsrivier. It consists of seven neighbouring farms. The other district, Olivedale, is on the other side of the river. The specific study sites used here were on three neighbouring farms, Kelkiewyn (A), Kromhout (B) and Arcardia (C), situated along the lower reaches of the Buffeljagsrivier and south of the village with the same name (Figure 1.4; Plate 1.2). These sites were chosen as they represent a range of intensity of land use from heavy grazing in particular through fallow grazing land to almost intact RSR.

1.4.3 Geology, topography and soil

The soils across the study sites are shallow with a layer of weathered silcrete rocks (Figure 1.5; Plate 1.1) on the surface. The underlying rock consists of shales of the Bokkeveld Group (Mucina & Rutherford, 2006). Soils are described as prisma- and pedocutanic. The elevation is between 80 and 120 m above sea level, and the aspect is northerly.

1.4.4 Climate

The study area and sites fall on the boundary between the Mediterranean climate of the south-western Cape and the summer rainfall area to the east and north. It is not as dry as the south-western Cape, and rain can occur any time of the year. The annual rainfall is around 511 mm (SanParks, 2006). Most (59%) of the rain falls in the winter months which are between April and October (SanParks, 2006). April and August are the wettest months, and December and January are the driest. Temperature varies between a maximum of 40ºC in summer and a minimum of below 0ºC in winter. The south-easterly winds are the dominant winds in summer in the area. In winter, the 'northwester' is the dominant wind, and it may bring cyclonic rain to the area.

1.4.5 Characteristics of study sites

The three farms selected for this study differed in their level of grazing intensity and plant species. The farms are described as follows:

a. Medium-grazed area (Kelkiewyn)

Kelkiewyn was an extensive poultry farm about 35 years ago when it went bankrupt and was bought by JP Franken (Figure 1.6; Plate 1.3). It consists of 35 ha which ranges today from degraded fields to intact Renosterveld. RSR covers about 7 ha of this farm. The Renosterveld was not used for grazing until the late 1990's, when it was grazed by some meat-production cattle. After that, it was left for about two years and then it was grazed by Jersey cows for five years. It has been only lightly grazed in the past decade by less than 10 individuals at a time. Seeding grasses are the dominant cover on this farm. The dominant grasses on the farm include *T. triandra*, *Cymbopogon marginatus*, *Digitaria eriantha* and *Heteropogon contortus*. *Searsia glauca*, *D. rhinocerotis*, *Oedera squarrosa*, *Aspalathus nigra* and *C. ruscifolia* are the dominant shrubs here. This farm also supports numerous geophytes.

b. Heavily grazed area (Kromhout)

Kromhout is a larger farm than Kelkiewyn (about 45 ha) and consists of planted pasture in the low-lying areas, and of natural, but heavily grazed, Renosterveld in the higher areas (Figure 1.7; Plate 1.3). This camp that contains RSR is around 10 ha in size. It is a dairy farm stocked with Jersey cows. The Renosterveld sections of the farm are used as fodder for the pregnant and non-productive cows. The stocking rate varied during the year. Some months there could be up to 30 head in the camp, followed by weeks with no animals in the veld (land owners do not keep accurate records of stocking rates, so precise data on stocking rates are not available). The farm has seen a change in ownership in 2007. The new owner is interested in restoring the grass component of the Renosterveld and is planning to rest the fields for a few more years yet.

The grass species are mostly the same as for Kelkiewyn, but the individual plants have been grazed short to the ground. *Dicerothamnus rhinocerotis* and *C. ruscifolia* are the dominant shrubs on the farm, followed by *O. squarrosa* and *A. nigra*. *S. glauca* is almost absent from this farm. This is the only farm in the study area were the alien, *Acacia cyclops* can be found as scattered trees.

c. Lightly grazed area (Arcardia)

Arcardia (Figure 1.6; Plate 1.3) is a 9 ha camp lying next to the farm Kromhout. It has not had any livestock on it for at least three decades and the farm is dominated by unpalatable grasses such as *M. stricta*. Shrubs like *D. rhinocerotis*, *C. ruscifolia* and *O. squarrosa* are not as numerous as on Kromhout. *Searsia glauca* is present on this farm. There are also large *Aloe ferox* plants, which may indicate that the farm has also not been ploughed for at least three decades as they are known to be slow growers (personal observation). This site is also the area that contains the largest concentration of the newly described and endemic succulent, *Haworthia groenewaldii*.

d. Other areas

Arcardia also contains thickets (Figure 1.9; Plate 1.3) dominated by succulents (especially *A. ferox*) and large shrubs and trees such as *Asparagus* spp., *Acacia karroo*, *S. glauca*, *Olea europaea*, *Buddleja saligna*. This farm also supports the protected White Milkwood tree, *Sideroxylon inerme*. Other succulents that are common here include *Euphorbia mauritanica*, *Cotyledon orbiculata* and *Carpobrotus edulis*. These species are slowly expanding from the formerly grazed areas into the RSR remnants on the farm. The dense structure of this vegetation makes it very difficult to explore, and it may contain organisms not yet listed for the area.

The RSR in the Buffeljagsrivier area has not been burned for at least three decades. All fires that have accidently been started were put out before they reached the areas that naturally require fire. In the areas that have had large grazers excluded, thickets have formed, which in turn, may pose a fire threat. The areas that are grazed have become dominated by Renosterbos and Steekbos, both of which can be controlled by fire. Without any fire, these species start to dominate and out-compete the grasses and other species in the veld (Raitt, 2005). Typically however, there is too little plant biomass in the overgrazed areas to burn in a controlled fire, but the lightly grazed and the thicket areas with their higher fuel load are likely to respond well to fire. Certain geophytes need fire to flower and produce seeds successfully (Goldblatt & Manning, 2000). The Critically Endangered and endemic *Cyranthus leptosiphon*, is a good example of a bulb that needs fire. *Boophone distica* is another rare bulb, growing in the area, which is stimulated to flower by fire.

Sandy areas that have been intensively ploughed in the past have lost most of their plant species, and are mostly dominated by *Cynodon dactylon* (Kweek) under heavy grazing. In the old fields that are not so heavily grazed, grasses like *Hyparrhenia hirta* and *Eragrostis curvula* may also be present. Some geophytes and weedy shrubs like *Athanasia trifurcata* also occur in these areas.

For this study, I mainly looked at the three differently-managed RSR farms and sites, but other areas were also used when compiling biota diversity lists and noting plant/animal interactions.

1.5 Problem statement

The RSR is known as critically endangered vegetation type, and the areas that are left should be managed in such a way that no further degradation takes place. Proper management can only be done if there is some knowledge of the species that occur naturally in the area, how they respond to different management regimes, and how they interact with each other. The following are some of the features of the RSR in the study area for which there is a dearth of information:

- No accurate list for plant species that occur in the study area exists. There may be rare or new species in the area that may need protection.
- There are no lists of the vertebrates that are specific to the study area. It is important to know what animals and birds occur in the area as they are dependent on, directly or indirectly (e.g. through invertebrates), the vegetation.
- Very little information is available on the effect that grazing by cattle may have on the plant structure and biodiversity of the RSR. Without this information, the veld may be managed sub-optimally by the farmers, especially in terms of biodiversity conservation.
- Almost nothing is known of the invertebrates that occur in the RSR. Invertebrates are known to play a major role in keeping ecosystems healthy, and they provide services, such as pollination and nutrient recycling, but can also be pests on crops. Knowledge on plant/animal interactions for the RSR is also lacking. These interactions may help to determine if the ecosystems are functioning normally or not.

1.6 Study objectives

In view of the above, the following are the objectives of this study:

- To compile a species list for the plants in the study area.
- To compile a species list for all the vertebrate species occurring in the study area.
- To improve our knowledge on the invertebrate biodiversity in the study area.
- To observe and note some significant plant/animal interactions that occurs in the study area.
- To investigate the effect that different grazing regimes have on the plant composition of the RSR.

Chapter 2: Flora of Rûens Silcrete Renosterveld of the Mullersrus area, Buffeljagsrivier in a regional perspective: plant diversity and grazing

2.1 Introduction

The Cape Floristic Region (CFR) is well known for its rich plant diversity (Kemper *et al*. 1999). The CFR can be divided into three main vegetation types: Fynbos, Renosterveld and Strandveld. Renosterveld is the most endangered of the three, and occurs on more fertile soils, making it more prone to agricultural development, especially cereals and pasture. The remaining natural fragments of Renosterveld are mostly those that are too steep or rocky to be ploughed. The Rûens Silcrete Renosterveld (RSR), the focus of this study, is particularly common along the lower Breede River, south of Buffeljagsrivier to Malagas (Mucina & Rutherford, 2006). The RSR is seen as a critically endangered vegetation type, as 78% of it has been transformed into agricultural land (Mucina & Rutherford, 2006). Yet the RSR contains rare and endemic plants that are sensitive to grazing and trampling, and requires no or minimal disturbance to remain intact (De Villiers *et al*. 2005).

Mullersrust is one of the two larger districts of the farming community of Buffeljagsrivier. It consists of around ten neighbouring farms. The lower lying area in the valley next to the Buffeljagsrivier is entirely converted into farmland. Fruit orchards cover the larger portion of this area, followed by planted pastures for cattle grazing. The higher lying areas are used for grazing by cattle and sheep, but much remains free of agricultural conversion.

Themeda triandra (Rooigras) and other grass species can be dominant in the RSR of the Buffeljagsrivier area and it provides fodder at the time of the year when the cattle are not producing milk. The occurrence of these grasses suggests that it must have been grazed by large mammals in the past (Raitt, 2005). Grazing and fire play an important role in keeping Renosterveld healthy (Cowling *et al*. 1986). However, indigenous large mammals are not present in the area any longer, having been hunted out by the early European settlers. Fire has also been absent for decades. The absence of both these types of herbivory leads to the transformation of the RSR into thickets. Yet, too much grazing leads to a shrub dominated veld, while too much fire to grassland (Raitt, 2005). It is thus important to strike an appropriate balance between these two factors when aiming to manage Renosterveld fragments to maintain botanical diversity. Large areas of the RSR have lost the original dominant grassy components (Skead, 1980), and are overgrown by unpalatable shrubs like

Elytropappus rhinocerotis (Renosterbos) and *Cliffortia ruscifolia* (Steekbos), and hard grasses like *Merxmuellera disticha* (Koperdraadgras).

According to the Bontebok National Park Management Plan (BNPMP) (2012), the study area falls within the buffer zone of the Bontebok National Park, and is rated as a Critical Biodiversity Area, Priority Natural Area and a Viewshed Protected Area for the park. According to the BNPMP, the last two areas can be described as follows:

"Priority natural areas: These are key areas for both pattern and process that are required for the long term persistence of biodiversity in and around the park. The zone also includes areas identified for future park expansion and corridor initiatives. Inappropriate development and negative land-use changes should be opposed in this area. Developments and activities should be restricted to sites that are already transformed. Only developments that contribute to ensuring conservation friendly land-use should be viewed favourably."

"Viewshed protection areas: These are areas where development is likely to impact on the aesthetic quality of the visitor's experience in a park. Within these areas any development proposals should be carefully screened to ensure that they do not impact excessively on the aesthetics of the park. The areas identified are only broadly indicative of sensitive areas, as at a fine scale many areas within this zone would be perfectly suited for development. In addition, major projects with large scale regional impacts may have to be considered even if they are outside the viewshed protection zone."

Although BNP has incorporated the study area into its zoning, no formal assessment of the area has yet taken place. In response, this study focuses on and compares the plant diversity and abundance in three differently-managed areas within the RSR. The total plant biodiversity of the overall area will also be recorded and compared with the nearby Bontebok National Park (BNP). Figure 2.1 shows the location and size of the park in comparison to that of the study area.

2.2 Methods

2.2.1 Plant checklist

Plants were recorded and identified through opportunistic surveys in the old fields and RSR between 2004 and 2012. All plant species were photographed where possible. Plants were also identified by members of Custodians of Rare and Endangered Wildflowers (CREW) who visited the area in 2011. Experts assisted with identification, and I-Spot was also used to

verify observations. The plant list for Bontebok National Park (Kraaij, 2010) was used to check the accuracy of the list, which is the most complete list in an area close to the study area. Goldblatt & Manning (2000) was used to check for CFR endemism and for identifying the plants. Bromilow (2010) was used to identify alien plants, while Manning *et al*. (2002) was used to identify some of the geophytes. SANBI (2012) was used to assign growth forms and standardize scientific names.

2.2.2 Grazing management sampling

Different methods were used to measure the effect that different grazing regimes had on the RSR. The three areas were chosen using available but scarce literature on Renosterveld management and liaising with farmers in the area. I also used my knowledge gained from living and farming in the study area from 1998 to select the best sites to be used. A more detailed description of these sites can be found in Chapter 1. Figure 2.1 shows the location and size of the park in comparison to that of the study area.

The under-grazed site in the area was chosen as it was dominated by the climax grass, *Merxmuellera disticha* which is seen as an indicator of old undisturbed Renosterveld (Raitt, 2005). This area has not had any cattle grazing for several decades.

The medium-grazed site contained spreading and healthy Rooigras that was only sporadically grazed in the summer months by less than ten individuals. The spread of this grass is seen as an indicator of healthy, well managed Renosterveld (Raitt, 2005).

The heavily-grazed site contained the same grass species as the medium-grazed site, but the individual plants were grazed short and have not been able to produce seed for many years. Another indicator of the heavy grazing at this site was the presence and dominance of Renosterbos, a known sign of heavy grazing in Renosterveld (Cowling, 1986; Rait, 2005; Skead, 1980; and others). Some signs of erosion are also seen in the overgrazed area. Possibly however, the poor state of this veld is a result of the farmer grazing his cattle on the veld at the wrong time of the year for the past decade, and not as a result of the high cattle load.

a) Plot method

This method was used on the medium- (Figure 2.2) and heavily-grazed (Figure 2.3) sites to investigate what affects grazing was having on both sides of the fence. The under-grazed site was not sampled using this method, as it contained a totally different vegetation composition and structure from the other two sites. In order to compare all three sites I used transects (see below).

These two chosen sites were divided further into two according to the absence or presence of *Cliffortia* (Cliffortiaveld) or Renosterbos (Renosterveld), hereafter referred to as vegetation types. Sites were sampled using 1 x 1 m plots. Ten plot samples were randomly taken in each vegetation type on both farms (40 in total). The species and the abundance of each species were recorded. The time spent at each plot was limited to 10 min so as to standardize the data. Whittaker's index of beta-diversity was used to determine the difference between plant diversity between Renosterveld and Cliffortiaveld under the two management regimes (heavily-grazed and medium-grazed). Beta-diversity estimates species turnover between sites (Whittaker, 1975). The closer the value is to one, the more the sites differ.

b) Line transect method (total cover)

Four 50 m line transects (as a length of tape measure) were set up at each site at each grazing level (medium-grazed and heavily-grazed sites, with no grazing as reference) and the plant species that crossed by the tape along all its length were recorded and identified. The length each plant occupied under the tape measure, were also recorded. These lines were, where possible, at least 50 m apart.

A canonical analysis of principal coordinates (CAP) was done in PRIMER 6 (PRIMER-E, 2008) to determine whether vegetation composition correlated significantly with grazing regime. A CAP analysis was chosen as it is an effective way to visualize the quantitative results, even if there are other unmeasured factors that could potentially have an effect on the data set (Crous *et al*. 2013). By using the 'leave-one out' allocation, one can check if the samples per site just contain a random combination of species or whether they do form distinctive groups (Crous *et al*. 2013). A CAP analysis was done using Bray-Curtis similarity measures, where the data from each sample were transformed by fourth-root transforming them. This transformation reduces the weight of the common species in the data set (Crous *et al*. 2013; Anderson, 2001).

c) Grazing capacity for the under, medium and heavily grazed sites

It is important to know what the grazing capacity of the different sites is as it can be used to prevent future overgrazing.

Plant species were recorded every 1 m along the 50 m line transects, as described in Esler *et al*. (2006). Plant species in contact with a spike, placed every 1 m, were recorded. This method was recommended by Esler *et al*. (2006) to calculate grazing capacity for Karoo-type vegetation. Esler *et al*. (2006) give a grazing score number for each plant species. If the species were not on the list, the closest relative was used. Mucina & Rutherford (2006) classified RSR as very close to Succulent Karoo and this method was tested in this study.

2.3 Results

2.3.1 Plant checklist

A total of 403 (480 with alien plants) indigenous plants species in 226 genera from 76 plant families were recorded in the study area (Table 2.1). Asteraceae (53 species) and Iridaceae (48 species) were the most specious, followed by Fabaceae and Poaceae. This species richness is typical of Renosterveld (Manning *et al*. 2002).

Table 2.1: List of the largest plant families recorded in the study area. The number of species (in decreasing order), number of genera, and number of threatened (Red Listed as Vulnerable, Endangered or Critically Endangered plant species are given

Family	Species	Genera	Red Listed species
Asteraceae	53	38	2
Iridaceae	48	13	11
Fabaceae	25	12	5
Poaceae	22	16	0
Hyacinthaceae	20	8	0
Mesembryanthemaceae	14	10	6
Oxalidaceae	13	1	0
Apocynaceae	12	11	1
Scrophulariaceae	12	8	0
Geraniaceae	11	2	0
Amaryllidaceae	9	8	2
Asphodelaceae	9	5	1
Malvaceae	9	3	0
Euphorbiaceae	8	2	2
Asparagaceae	7	1	0
Cyperaceae	7	3	0

Hypoxidaceae	7	3	0
Anacardiaceae	6	1	0
Campanulaceae	6	3	0
Lobeliaceae	6	2	0
Thymelaeaceae	6	3	0
Eriospermaceae	5	1	0
Polygalaceae	5	2	1
Totals: 76	403	226	33

All species were divided into one of eight groups (life forms): shrub, herb, tree, geophytes, climber, graminoid, and succulent or dwarf shrub. These were done for the indigenous (Figure 2.4) and exotic plants (Figure 2.5.).

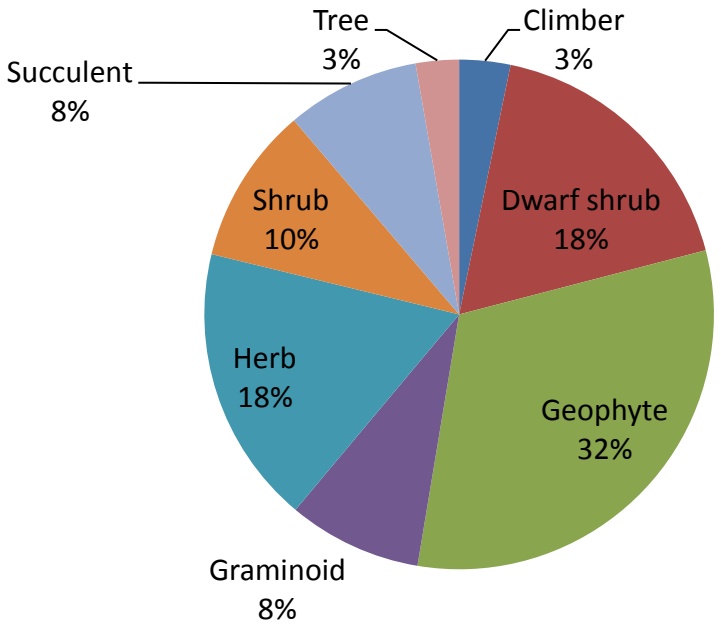

Figure 2.4: Growth form composition of the indigenous plant species recorded in the study area.

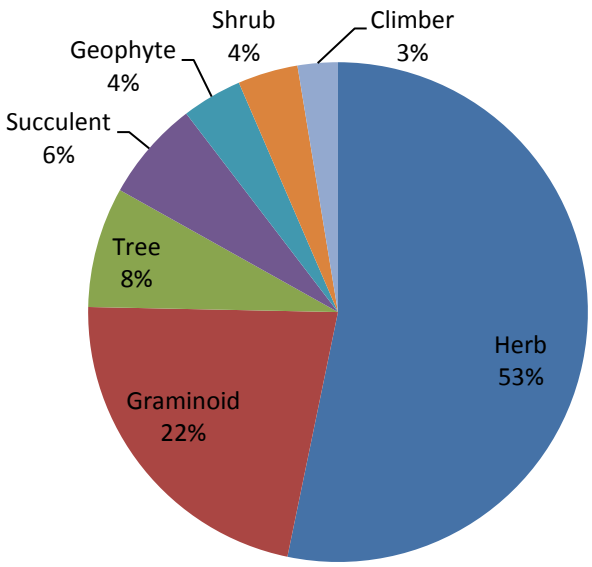

Figure 2.5: Growth form composition of the exotic plant species recorded in the study area.

The complete checklist of all plant species, both indigenous and alien, is given in Appendix 1. The study site contains about 17% of the recorded plant species that occur in the Langeberg Centre mapped by Goldblatt and Manning (2000). SANBI (2012) lists 353, indigenous plants species, for the 3420BA map (1:25000) in which my entire study site is located. However, only 93 species of the species listed were recorded in this study.

The Bontebok National Park (BNP) is the largest natural area close to the study site, and its vegetation composition/type is also the only one that can be compared with the study area. The BNP contains 650 plant species in 280 genera from 85 families. All of these BNP species will not be RSR plant species, as the list contains riverine as well as additional fynbos species (Proteaceae, Ericaceae and Restionaceae). Of this number, 216 species from 59 families also were recorded in the study area. A total of 175 plant genera were shared between BNP and the study area. The BNP has a surface area of 3435 ha, while the study area is only around 150 ha. A total of 2.67 plant species per ha were recorded in the study area, compared to 0.19 per ha for the BNP.

2.3.2 Grazing management

a. Plot method (for medium-grazed and heavily-grazed sites)

The 40 plots contained 100 plant species in total. Figure 2.6 compares the plant type composition of the four sites. The four sites comprise of a *Cliffortia*-dominated area (Cliffortiaveld) and Renosterbos dominated area (Renosterveld) on both sides of the fence line. Renosterveld contained more dwarf shrubs and less geophyte species than Cliffortiaveld.

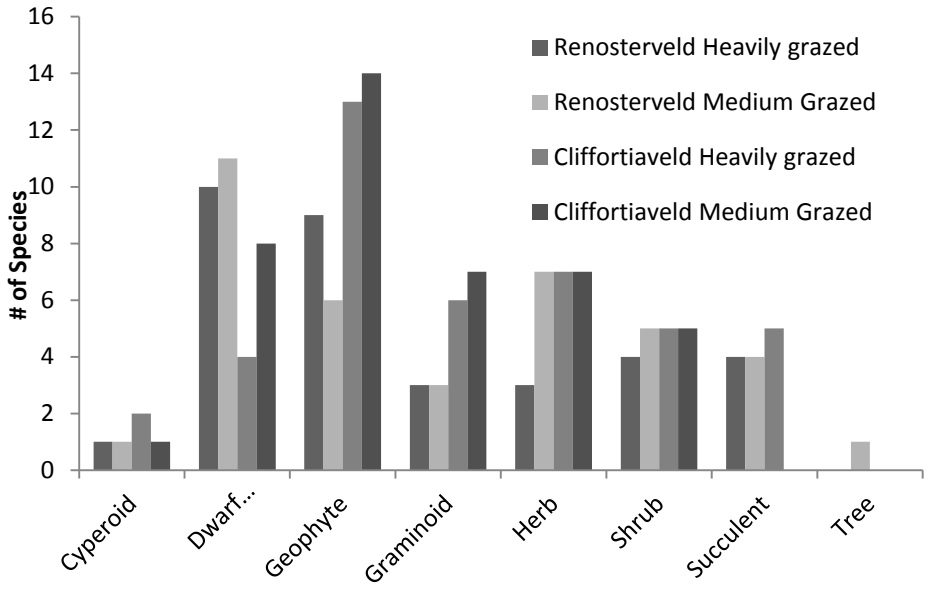

Figure 2.6: Total number of plant species belonging to different plant types which were recorded in the plots.

Renosterveld contained 34 and 38 species when respectively heavily and medium grazed, while Cliffortiaveld had 42 species under heavy or medium grazing pressure.

Beta-diversity between pairs of the four vegetation types showed that there is a large difference between the plant species found in the Renosterbos dominated and Cliffortia dominated Renosterveld. The largest differences were found were both vegetation types were medium grazed.

Table 2.2: Beta-diversity between the medium- and heavily-grazed areas, and between Renosterveld and Cliffortiaveld.

Comparison	β-diversity value
Medium vs. Heavily grazed	0.523
Medium Grazed vs. Heavily grazed Cliffortiaveld	0.662
Medium vs. Heavily Grazed Renosterveld	0.611
Heavily Renosterveld vs. Heavily grazed Cliffortiaveld	0.6
Medium grazed Renosterveld vs. Medium grazed Clifforthiaveld	0.75
Renosterveld vs. Cliffortiaveld	0.559

b. Line Transect

The percentage cover for the three dominant growth forms as well the percentage bare ground, was calculated for each site. Results are given in Figure 2.7. These data are for the total cover (200 m per grazing management) and not the average cover per 50 m line. Grass cover goes down as the grazing pressure increase. The heavily grazed area contained a larger shrub cover than the other sites. The two grazed areas had more bare ground.

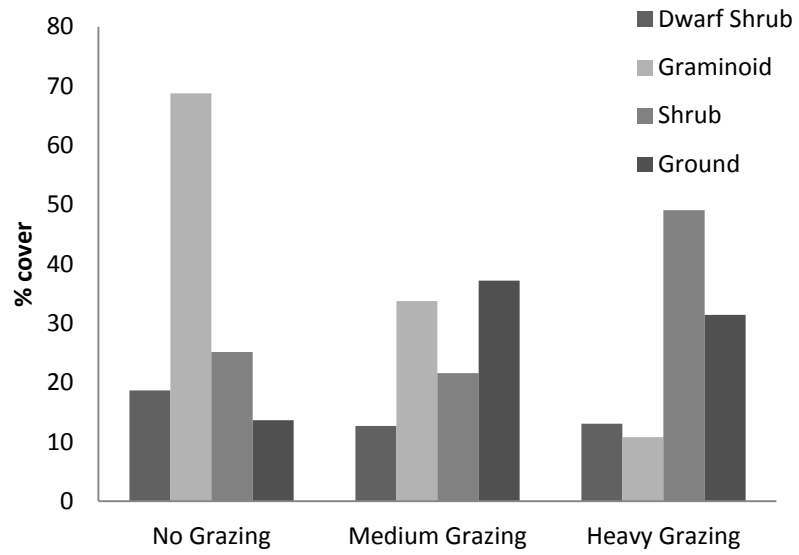

Figure 2.7: This figure gives the percentage cover for the three dominant growth forms, as well the percentage bare ground, for the three differently grazed areas.

The number of species per growth form was also determined for the three differently grazed sites (3 x 200 m). The medium grazed area contained the most herb species. Geophyte diversity was found to be the lowest where it has been heavily grazed. No and heavily grazed areas were found to contain more dwarf shrubs. Results are given in Figure 2.8.

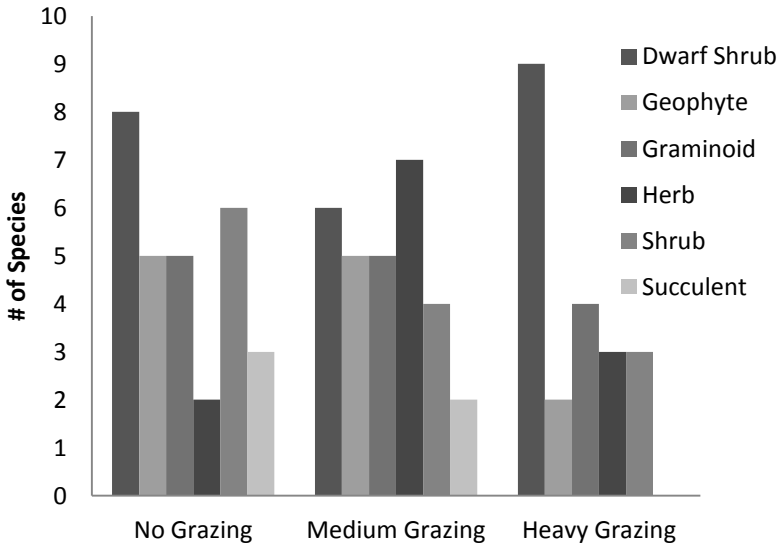

Figure 2.8: Number of species per growth form for the three differently grazed sites.

Canonical analysis of principal coordinates test found that the samples within the differently managed sites do not contain a random array of plant species, but distinctive groups (Fig 2.9). The stress test also confirmed that the samples were not mixed.

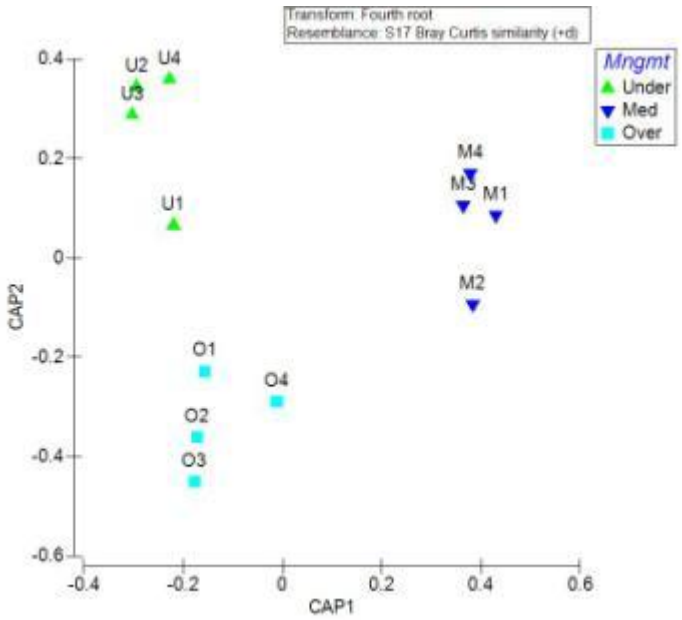

Figure 2.9: Canonical analysis of principal coordinates test on data obtained from the line transects. O1-O4, Overgrazed transects; M1-M4, Medium grazed transects and U1-U4 stand for the lightly (Under) grazes transects.

c. Carrying capacity

The carrying capacity in ha/large livestock unit (according to the method of Esler *et al*, 2006) for the three differently grazed camps were: 5.13 for the no grazing site, 12.1 for the medium-grazed site and 14.9 for the heavily-grazed site.

2.4 Discussion

2.4.1 Area Checklist

Renosterveld is known to be rich in geophyte species (Manning *et al*. 2002), and the study area contained 127 of the 247 recorded species (51%) in the Langeberg Centre (Manning *et al*. 2002). The BNP has 145 species of geophytes (Kraaij, 2011), with 64 shared with the study area. The study area also contained many of succulent and other species that occur over the Langeberg Mountains in the Succulent Karoo (pers observ.; Mucina & Rutherford, 2006).

Trees were not an abundant feature of the study area (Skead, 1980) and the few species that do occur there are in the wetter ravines. They are also found in areas that were degraded or not grazed or burned for decades. *Acacia karroo* is the most abundant tree species in the study area, with the local area being known as 'Thornlands' in the past. Although grass

species richness was found to be low in the study area, they never the less covered a large part of the study area, with some local landscapes appearing like typical grasslands from the Eastern Cape (Skead, 1980). A total of 149 (37% of the total recorded) plant species that are endemic to the CFR were recorded in the study area. The BNP has 299 (46% of the total) species that are endemic to the CFR.

a. Species of conservation concern

Thirty-three species of conservation concern were recorded in the study area, while 19 plant species recorded here are categorised as threatened (BNP contains 29). Three are Critically Endangered (BNP contains 1), five Endangered (BNP contains15), and 11 Vulnerable (BNP contains 13). Another 15 plant species are also of conservation concern, 11 are Near Threatened (same as BNP), two species are declining in numbers (BNP contains 6), and two Data Deficient (BNP contains 6). Iridaceae (11 species) contains the most species of conservation concern, followed by the Mesembryanthemaceae (6 species) and Fabaceae (4 species). *Diosma fallax* (Figure 2.10) is a buchu species thought to be endemic to the BNP (Kraaij, 2010) and was found in low abundance in the study area.

Haworthia groenewaldii (Figure 2.11) is a plant species discovered only five years ago in this area. It was thought to be confined to the study area, but in 2012 other populations were discovered on the other side of the Buffeljagsrivier close to BNP. It only occurs in silcrete Renosterveld, and is endemic to the Buffeljagsrivier area (Breuer *et al*. 2011). *Wiborgiella bowieana* (Figure 2.12) is a Critically Endangered species thought only to have three populations remaining. A population of 33 plants was noted in July 2012 in the study area. *Cyrtanthus leptosiphon* (Figure 2.13) is another endemic bulb species from the Buffeljagsrivier area. It is thought that its pollinating agent, the long-tongued fly (*Prosoeca longipennis*) may have gone extinct in the area and that it cannot reproduce (Manning *et al*. 2002). The absence of fire, which stimulates flowering, has also had an effect on this species reproduction (Manning *et al*. 2002). This species may be pollinated by the Sphingidae moths *Agrius convolvuli* and *Hippotion eson*, as they were found visiting *Crinum* flowers (also Amaryllidaceae) at night, that occur in a garden near the study area. These moths have not to date been rerecorded visiting *C. leptosiphon* but seeds observed at numerous times in the veld.

b. Alien species

A total of 77 alien species were recorded in the study area. Annual grasses and herbs were the dominant aliens, but the exact negative effect that these have on the natural vegetation is not known. These alien grasses are heavily grazed by cattle at the wetter times of the year and this grazing may be limiting any further spread.

2.4.2 Grazing management regimes

There is a clear difference between the plant species from Renosterbos-dominated areas and the *Cliffortia*-dominated areas. There was a 56% species turnover between the different areas. The turnover was largest (75%) in the medium-grazed camp. The overall species turnover between the differently-grazed areas was the lowest, but it was still above 50%, giving the variously-grazed areas a different appearance.

The Renosterbos-dominated areas had more *T. triandra* (Rooigras) individuals than the *Cliffortia*-dominated vegetation. This was especially true in the Kelkiewyn area. The Cliffortiaveld parts of Kelkiewyn did not support any Rooigras individuals. The only difference between the two farms was the height and density of the plants. The plants on Kromhout were very sparse and grazed short to the ground. Rooigras is sensitive to frequent defoliation and the rate of tiller production depends on the height and frequency of defoliation (Raitt, 2005). The plants do not flower if they are grazed continuously, as the plants do not get chance to produce seeds and then senesce, leading to loss of the seed bank, as seeds have a limited lifespan of 2-3 years (Raitt, 2005). Seeds are also lost from the seed bank by grazing, deep burial, decay and predation (Raitt, 2005). It was found that heavy grazing can lead to the disappearance of Rooigras within seven years, and that it can take up to eight years before the grass reappears in the local area. Raitt's (2005) study was done in Zimbabwe, where conditions differ from the study area here. The grass in the RSR has been grazed for longer than seven years, although the cattle load in this area may possibly be lower. Rooigras plants can live for <20 years without fire or grazing, but these plants have weak and long stems that do not produce healthy flower heads (Raitt, 2005). Grazing and fire helps to keep the plants healthy and strong, but they must be present at the right intensity (Raitt, 2005).

The Rooigras individuals on the farm Kelkiewyn, on the other hand, are dense and spreading. The grazing intensity is low enough to allow the grass to flower and set seed. This is the result of the lower stocking rate in the past and the fact that the field was left to rest at the right time of year. Veld should be grazed in the wetter times of the year, when the grasses and bulbs flower and set seed (Raitt, 2005).

Cliffortia ruscifolia is a thorny, unpalatable plant that has spread as a result of overgrazing and/or the absence of fire in the area (Raitt, 2005). This could be the reason why large parts of both farms are overgrown by it. *Hyparrhenia hirta* and *Melinis repens* were the two dominant grass species growing between the *Cliffortia* plants on Kelkiewyn. The dominance of these grasses is an indication that the area was previously disturbed by grazing (van Oudtshoorn, 1999). The reason why they were absent from Kromhout is that they did not get chance to become reproductive in the area as the young plants were grazed down by cattle before they set seed. Both grasses prefer to grow on well drained soils (van Oudtshoorn, 1999) which may be why they do not grow on the heavier Renosterbos soils. These grasses also commonly grow in disturbed areas next to roads. *H. hirta* and *M. repens* was also found to spread into areas that were heavily grazed for a short time and then left to rest for a few years. A neighbouring farmer used this response to turn a formerly heavily-grazed and ploughed old field dominated by *D. rhinocerotis*, into a more diverse type of grassland that can be used for grazing.

I chose the medium-grazed sites (Kelkiewyn) as the most natural veld as it contains the most palatable climax grasses, including the grasses *M. stricta, D. rhinocerotis* and *T. triandra*. If the grazing is too low, the area becomes overgrown by unpalatable *M. stricta*. It only grew on the site that were not grazed and was the dominant cover for that site with almost a 60% cover. This grass can, over time, replace all the other grasses and weaken the growth of bulbs. *Merxmuellera stricta* is known as a climax grass and its dominant presence in Renosterveld is a good indicator that the veld is old and needs to be burned to be rejuvenated (Raitt, 2005). From the data here, *T. triandra* seems to be more sensitive to competition by *M. stricta* than to grazing.

Dicerothamnus rhinocerotis (Renosterbos) was found at all the sites, but it was the most dominant in areas that were heavily-grazed. It is a very hard, aromatic plant that is not often grazed. Large areas on the Western Cape have been invaded by this shrub (Raitt, 2005;

Cowling, 1986). This has been the result of poor veld management, partly because there has been confusion between Renosterveld and Renosterbos-dominated veld. The presence of Renosterbos does not necessarily mean that the veld is Renosterveld. The shrub also invades old ploughed fields that have little value for conservation.

Grazing and fire are important for keeping populations healthy, although it is not certain how much and how frequent the area must be grazed and burned. Too frequent burning may have a negative effect on Renosterveld (Kraaij, 2010a), and this approach should be fully researched before it is implemented as a management tool for other areas. Too little fire will lead to the formation of shrubby vegetation without any edible plants, while if the area is burned too frequently, the area will become grassland as the fire kills the shrubs. Cowling (1986) argues that much of the Renosterveld on the South Coast of South Africa has been derived from *T. triandra*-dominated grassland, which suggests that use of more frequent fires is possibly the most appropriate management. The shrubby nature of the RSR today can thus be attributed to the European settlers (Cowling, 1986; Raitt, 2005), with incorrect fire regimes and overgrazing having led to the demise of the grassland, although it has led to the formation of a more diverse habitat with a greater diversity of plant species and subsequently on other species that benefit from more bushy vegetation.

The Grazing capacity method, used by Esler et al. (2006) for the Karoo, did not work well for the RSR. It did give some expected results but some of the results could be misleading. The lightly grazed site was almost totally covered in *M. stricta*. This grass may not be as palatable as the forms found in the Klein Karoo. Problems also arose when more than one species touches the spike. Furthermore, the method only uses presence of species and does not take into account that the plants could be overgrazed and unable to reproduce. This method was consequently found not to be useful to determine sustainable grazing capacity in order to recommend grazing intensity in the study area.

2.5 Conclusion

The RSR patches that remain are not well studied, and this study increases the knowledge we have about these special habitats. The study area forms part of the larger area remaining of a Critically Endangered Vegetation type. It falls in the buffer zone of the BNP, an area rated as a Critical Biodiversity Area, Priority Natural Area and as a Viewshed Protected Area, making

the RSR an area of great conservation concern. This is the first botanical inventory done on the Renosterveld in the Mullersrus area, with the plant biodiversity for the study area being found to be high. The area contains many species of conservation concern, as well as species not recorded in the area before now. Indeed, this study led to the discovery of a new plant species, as well as discovering a new population of the Critically Endangered plant species (*Wiborgiella bowieana*). This study found that Plants of Southern Africa (an online checklist) compiled by SANBI needs updating for the area as easily-identifiable species were absent from the current list.

The Bray-Curtis similarity measures were found here to be a useful tool for distinguishing between differently-managed grazing areas. Furthermore, the data obtained here can be used to classify the grazing regime of other camps in the larger Buffeljagsrivier area. In practice, this can be done by comparing 200 m line transect (4 x 50 m) results from other camps with those in this study. The fact that the different landscape/grazing camps in the study area had different management regimes, makes it a valuable area for Renosterveld management research. It was found that, even if a RSR camp seems to be heavily grazed it may still contain special and rare species as well as useful (for grazing) ones. Areas that are not grazed seemed to contain less grazible plants. This knowledge can be used to compile a management plan for the area, and assist in establishing it as a Conservation Area or to assist the farmers on the use of the veld on a sustainable basis.

Chapter 3: Animal biodiversity and select plant/animal interactions in Rûens Silcrete Renosterveld

3.1 Introduction

The previous chapter showed that the plant diversity in the Rûens Silcrete Renosterveld (RSR) is high and characteristic. A total of 403 (480 when alien plants are also included) indigenous plants species in 226 genera from 76 plant families were recorded in the study area. Of these plants 37% endemic to the Cape Floristic Region (CFR), with thirty-three of the recorded species are of conservation concern. A question arises whether the faunistic component of the RSR is as rich and unique as that of the flora. The aim of this chapter is to investigate the animal fauna present in the RSR, as well as some plant-insect interactions. The RSR is part of the vegetation type known as Renosterveld (Mucina & Rutherford, 2006) where birds and mammals have been well documented. Early travellers through the area noted an abundance of large game (Skead, 1980; Kraaij *et al*., 2009). Most of these large animals are absent from the area today, but some are still present in protected areas (e.g. Bontebok National Park (BNP) and on farms with natural vegetation. However, there is scant knowledge on the invertebrate fauna of the area, and especially how it might interact with the plant community.

Local insect communities play an important role in maintaining ecosystems intact (Wilson, 1987; Samways, 2005; Hudson *et al*., 2006; and others). For example, pollinators in the Cape Floristic Region (CFR) include species of Hymenoptera, Coleoptera, Diptera and Lepidoptera (Kehinde & Samways, 2012, Vrdoljak & Samways, 2011). Certain plants are so specialised that they can only be pollinated by a specific insect species. Examples of these include the long tube flowers of some species of Iridaceae and Amaryllidaceae (Barraclough & Slotow, 2010; Johnson & Steiner, 2000). Some of these species are under threat because their pollinators are under threat. For example, *Cyrtanthus leptosiphon*, an endemic bulb species from the Buffeljagsrivier area, is classified as Critically Endangered as it is thought that its pollinator went extinct in the area (Snijman & Victor, 2004). It may have been pollinated by a species like *Prosoeca longipennis*, a long-tongued fly species, that pollinates plants with similar flowers (Snyman, 1999), and today occurs in the Langeberg region. Furthermore, certain plants (around 1000 species in the CFR) produce seeds that are dispersed by ants. The seeds contain an extra edible part (the elaiosome) and certain ants carry them to their nest (Goldblatt & Manning, 2000). The ants only eat the edible part of the seed and leave the

viable remains of the seed in their nest (Goldblatt & Manning, 2000). Once underground, the seed is safe from rodents and other predators. The nests are a location which is suitable for germination, as the ant frass provides nutrients (Goldblatt & Manning, 2000). Insects such as termites and grasshoppers can be the main plant herbivores in an area and this plant-insect interaction plays a significant role in maintaining bio-cycles (Samways, 2005). In some arid areas in South Africa, the frass from termites is one of the few sources of nutrients for plants (Milton, 1995).

Lepidoptera is a highly diverse insect order with more than 160,000 named species worldwide (New, 2004), with many species interacting with several plant species in some way as pollinating adults. However, some species have larvae which are herbivorous on specific species (Woodhall, 2005).

Some Diptera, Hymenoptera and Lepidoptera induce galls on certain plants (Bairstow *et al*., 2010; Veldtman & McGeoch, 2003). Galls can form on different parts of the plant, with many stunting the growth or reproduction of individuals of the species. These galls can contain secondary insect species that live on the galls or on the insects that formed the galls (Veldtman *et al*., 2011). Some of the secondary gall invaders have also proved to be agricultural pests. The False Codling Moth (*Thaumatotibia leucotreta*), Litchi Moth (*Cryptophlebia peltastica*) and the Carob Moth (*Ectomyelois ceratoniae*) have been bred out (personal observation) of *Trichilogaster signiventris* galls found on *Acacia pycnantha*. Historically, conservationists have focused on plant and animal conservation without looking at the invertebrates to the same extent (Samways, 2005). This view may have led to the extinction of certain organisms which depend on interactions with invertebrates for their survival. Potentially at least, this may lead to the failure of some ecosystems to maintain their original function and the services that they provide. In recent decades, conservationists have realised that to conserve the ecological integrity of natural areas, they should include invertebrates as well as plants and invertebrates (and fungi also).

By monitoring certain groups of insects, it is possible to determine the state of certain terrestrial ecosystems. The fact that many insect species are only found to interact with specific plant species can be useful in this regard. Insect biodiversity can thus be used to a certain degree to determine plant biodiversity and vice versa (Gerlach *et al*., 2013).

Information about invertebrate diversity of the Western Cape is still scarce, and only the well-known groups, like dragonflies (Samways, 1999, 2008), and butterflies (Woodall 2005),

have been studied extensively, with others, such as ants (Botes *et al*., 2006), only sporadically surveyed.

In terms of invertebrate biodiversity, only the Bontebok National Park has only been surveyed for Colembola (Coates, 1970) and for benthic invertebrates undertaken during water quality assessments using the South Africa Scoring System (SASS) (Coetzer, 1986). Few studies have been done on plant/invertebrate interactions in Renosterveld. Bearing in mind the high plant diversity of the study area (±480 species), one would possibly expect high insect diversity. This chapter focuses on such interactions in the RSR in the Buffeljagsrivier area, especially interactions with invertebrates. The species *Acacia karroo* and *Searsia glauca* are dominant species in parts of the area, and bearing this in mind, the aim here is also to include them in this survey of plant-associated invertebrates. Lepidoptera, especially moths, have been poorly explored in the area, yet are a major taxon, and so some emphasis will be focused on them here.

3.2 Materials and methods

3.2.1 Vertebrates and their manifestations

Most vertebrates were observed in the area from 2000-2013. Frogs were searched for at night, using their calls to locate them. Others were observed in a water channel passing through the study area, and one species was retrieved from a domestic cat. Reptiles were searched for beneath rocks and by visual surveys. Reptile carcasses were also recorded. Birds were recorded from 1998-2013 by regular observation through binoculars. Bird carcasses were also recorded. Mammals were recorded as they were observed while walking (or sampling other taxa) in the study area. Dung was also used to identify some of the mammals. Some were also rescued from the water channel passing through the area, others were not so lucky and there carcasses were removed from the channel or found in the veld.

3.2.2 Sampling invertebrates

Grasshoppers were sampled at three natural and three heavily disturbed sites (see below). All grasshoppers were captured in a 50 x 50 m quadrant at each of the six sites for a total of 1hr/site. Additional species in the overall study area were recorded through casual observation. Flower-visiting and some other insects were sampled with pan traps consisting of 30 cm x 40 cm plastic trays deployed November-December 2011. Four pan traps (two

blue and two yellow) were installed per site, and partially filled with water and also a drop of detergent to reduce surface tension. These traps were places on the ground in the veld. They were 25 m away from each other in a square pattern. Three sites were used for pan trapping: one highly grazed, one lightly grazed, and one that had not received any grazing by cattle for at least two decades. These sites were in same camps used for the vegetation sampling. Insect samples were collected after the traps were set for four days. Sampled insects were stored in 80% ethyl alcohol and later pinned.

Insects were further randomly surveyed through observation, by being photographed, and searched for under stones, sweep netting, and light trapping. Some larvae were later reared to maturity. They were identified by the help of field guides and by staff at Stellenbosch University's Entomology Department.

3.2.3 Animal/plant interactions

The two dominant tree species, *A. karroo* and *S. glauca*, were opportunistically observed over a time (2009-2012) and all interactions between these tree species and other organisms were noted. These observations were mostly randomly done while walking and working in the area by night and day. Samples of galls were taken from the plants, and the insects were reared out in containers to identify the insects responsible for gall formation. Some other plant species were also randomly observed for interactions.

3.3 Results and discussion

3.3.1 Vertebrates

A total of 12 frog species were found to occur in the area (Table 3.1). The Painted Reed Frog only appeared in 2008 and has since become one of the most common species.

Table 3.1: Checklist of frog species recorded in the study area. Species marked with * are those not recorded on the Bontebok National Park checklist.

Species	Common Name
Xenopus laevis	Common Platanna
Semnodactylus wealii	Rattling Frog
*Hyperolius horstocki**	Arum Lily Reed Frog
*Hyperolius marmoratus verrucosus**	Painted Reed Frog
Tomopterna delalandii	Cape Sand Frog
Bufo rangeri	Raucous Toad

Strongylopus facciatus	Striped Stream Frog
*Strongylopus bonaspei**	Banded Stream Frog
Afrana fuscigula	Cape River Frog
Strongylopus grayii	Clicking Stream Frog
Cacosternum nanum	Bronze Caco
Cacosternum boettgeri	Common Caco

A total of 22 reptile species were recorded in the study area, including 13 snake species, four tortoise species and five lizards (Table 3.2).

Table 3.2: Reptiles recorded in the study area. Species marked with * are those not recorded in the Bontebok National Park list.

Snakes (Order Serpentes)	**Common Name**
Naja nivea	Cape Cobra
Bitis arietans	Puff Adder
*Honoroselaps lacteus**	Spotted Harlequin Snake
Psammophis notostictus	Karoo Whip Snake
Psammophis crucifer	Cross-marked Grass-snake
Psammophylax rhombeatus	Spotted Skaapsteker
Crotaphopeltis hotamboeia	Herald Snake
*Lamprophis capensis**	Brown House Snake
Lamprophis inornatus	Olive house Snake
Lycodonomorphus rufulus	Common Brown Water Snake
Duberria lutrix	Common Slug-eater
Thyplops lalandii	Delande's Blind Snake
Dispholidus typus	Green Tree-snake
Tortoises (Order Testudines)	
Chersina angulate	Angulated Tortoise
Homopus areolatus	Common Padloper
Geochelone pardalis	Leopard Tortoise
Pelomedusa subrufa	Cape Terrapin

Lizards (Order Sauria)	
Pachydactylus geitje	Ocellated Thick-toed Gecko
Agama atra	Southern Rock Agama
Mabuya capensis	Three-striped Skink
*Chamaesaura anguina**	Cape Grass Lizard
*Afrogecko porphyreus**	Marbled Leaf-toed Gecko

A total 122 bird species were recorded in the study area (Appendix 2). Of these, sixty-one species were associated with *A. karroo* and 42 with *S. glauca* (Table 3.3). Fifty-six bird species were found to use *A. karroo* trees as perches, while 35 species used *A. karroo* to obtain food either directly (feeding on parts) or indirectly (searching for invertebrates). Thirty-three bird species used *A. karroo* as a nesting site.

Only six bird species used *S. glauca* as a nesting site. However, many bird species used this species as a food source. About 30 bird species fed on its fruit, and 11 more hunted insects attracted by its flowers and foliage.

Table 3.3: Interactions between bird species and *Acacia karroo*/*Searsia glauca* in the study area.

		Acacia karroo				*Searsia glauca*			
Species	**Common name**	***Perch***	***Nests***	***Feed***	**Feeds on**	***Perch***	***Nests***	***Feed***	**Feeds on**
Anhinga rufa	African Darter	*							
Apalis thoracica	Bar-throated Apalis		*	*	invertebrates	*		*	invertebrates
Ardea cinerea	Grey Heron	*							
Ardea melanocephala	Black-headed Heron	*							
Bostrychia hagedash	Hadeda Ibis	*							
Bubo africanus	Spotted Eagle-Owl	*							
Bubulcus ibis	Cattle Egret	*							
Buteo rufofuscus	Jackal Buzzard	*	*						
Centropus burchellii	Burchell's Coucal	*	*				*		
Ceryle rudis	Pied Kingfisher	*							
Chalcomitra amethystine	Amethyst Sunbird			*	invertebrates			*	invertebrates
Chrysococcyx caprius	Diderick Cuckoo	*	*	*	invertebrates			*	invertebrates
Chrysococcyx klaas	Klaas's Cuckoo	*	*	*	invertebrates			*	invertebrates
Cinnyris afer	Greater Double-collared Sunbird			*	invertebrates			*	invertebrates
Cinnyris chalybeus	Southern Double-collared Sunbird			*	invertebrates			*	invertebrates
Cisticola fulvicapilla	Neddicky							*	invertebrates
Coccopygia melanotis	Swee Waxbill							*	fruit
Colius striatus	Speckled Mousebird	*		*	flowers			*	fruit
Columba guinea	Speckled Pigeon	*		*	seeds			*	fruit
Corvus capensis	Cape Crow	*	*						
Cossypha caffra	Cape Robin-Chat						*	*	invertebrates
Crithagra albogularis	White-throated Canary	*	*	*	seeds	*		*	fruit
Crithagra flaviventris	Yellow Canary	*	*	*	seeds	*		*	fruit

Crithagra gularis	Streaky-headed Seedeater	*	*	*	seeds	*		*	fruit
Crithagra scotops	Forest Canary	*	*	*	seeds	*		*	fruit
Crithagra sulphuratus	Brimstone Canary	*	*	*	seeds	*		*	fruit
Cuculus solitaries	Redchested Cuckoo	*							
Dendropicos fuscescens	Cardinal Woodpecker	*	*	*	invertebrates				
Dicrurus adsimilis	Fork-tailed Drongo	*	*			*			
Elanus caeruleus	Black-shouldered Kite	*	*						
Estrilda astrild	Common Waxbill							*	fruit
Euplectes capensis	Yellow Bishop							*	fruit
Euplectes orix	Southern Red Bishop	*	*					*	fruit
Halcyon albiventris	Brown-hooded Kingfisher	*							
Haliaeetus vocifer	African Fish-Eagle	*							
Indicator minor	Lesser Honeyguide	*	*	*	invertebrates				
Lanius collaris	Common Fiscal	*	*	*	invertebrates				
Megaceryle maximus	Giant Kingfisher	*							
Milvus aegyptius	Yellow-billed Kite	*							
Nectarinia famosa	Malachite Sunbird	*		*	invertebrates				
Numida meleagris	Helmeted Guineafowl	*		*	invertebrates			*	fruit
Oena capensis	Namaqua Dove	*	*	*	invertebrates			*	fruit
Onychognathus morio	Red-winged Starling	*						*	fruit
Passer domesticus	House Sparrow	*	*	*	seeds			*	fruit
Passer melanurus	Cape Sparrow	*	*	*	seeds			*	fruit
Phalacrocorax africanus	Reed Cormorant	*							
Phalacrocorax carbo	White-breasted Cormorant	*							
Ploceus capensis	Cape Weaver	*	*	*	seeds			*	fruit
Pternistis capensis	Cape Spurfowl							*	fruit
Pycnonotus capensis	Cape Bulbul	*	*	*	invertebrates	*		*	fruit

Scopus umbretta	Hamerkop	*	*	*					
Serinus canicollis	Cape Canary	*	*	*	seeds			*	fruit
Sigelus silens	Fiscal Flycatcher	*	*	*	invertebrates	*		*	invertebrates
Spreo bicolor	Pied Starling	*						*	fruit
Stenostira scita	Fairy Flycatcher	*				*			
Streptopelia capicola	Cape Turtle-Dove	*	*	*	seeds	*	*	*	fruit
Streptopelia semitorquata	Red-eyed Dove	*	*	*	seeds	*	*	*	fruit
Streptopelia senegalensis	Laughing Dove	*	*	*	seeds	*	*	*	fruit
Sturnus vulgaris	Common Starling							*	fruit
Sylvietta rufescens	Long-billed Crombec							*	fruit
Telophorus zeylonus	Bokmakierie	*		*	invertebrates	*	*	*	invertebrates
Terpsiphone viridis	African Paradise-Flycatcher	*	*	*	invertebrates				
Tricholaema leucomelas	Acacia Pied Barbet	*	*	*	invertebrates			*	fruit
Turdus olivaceus	Olive Thrush	*		*	invertebrates			*	invertebrates
Upupa africana	African Hoopoe	*	*						
Urocolius indicus	Red-faced Mousebird	*	*	*	flowers	*		*	fruit
Vidua macroura	Pin-tailed Whydah	*						*	fruit
Zosterops virens	Cape White-eye	*	*	*	invertebrates			*	fruit
	Totals:	56	33	35		15	6	41	

A total of 30 mammal species were recorded in the study area (Table 3.4). Ten of these were rodent species, three antelopes, ten small carnivores, and five insectivores.

Table 3.4: Mammal species recorded in the study area.

Order INSECTIVORA	
Chrysochloris asiatica	Cape Golden Mole
Myosorex varius	Forest Shrew
Crocidura cyanea	Reddish-grey Musk Shrew
Order CHIROPTERA	
*Rhinolophus clivosus**	Geoffroy's Horseshoe Bat
Eptessicus capensis	Cape Serotine Bat
Order LAGOMORPHA	
Lepus saxatilis	Scrub Hare
*Pronolagus rupestris**	Smith's Red Rock Rabbit
Order RODENTIA	
Cryptomys hottentotus	Common Molerat
*Georychus capensis**	Cape Molerat
Hystrix africaeaustralis	Porcupine
Dendromus melanotis	Grey Climbing Mouse
*Dasymys incomtus**	Water Rat
Rhabdomys pumilio	Striped Mouse
Mus minutoides	Pygmy Mouse
Mus musculus	House Mouse
Rattus rattus	House Rat
Otomys irroratus	Vlei Rat
Tatera afra	
Order CARNIVORA	
Vulpes chama	Cape Fox
Aonyx capensis	Cape Clawless Otter
Ictonyx striatus	Striped Polecat
Galerella pulverulenta	Small Grey Mongoose
Atilax paludinosus	Water Mongoose
Cynictis penicillata	Yellow Mongoose
Genetta genetta	Small-spotted Genet
*Genetta tigrina**	Large-spotted Genet
Felis libyca	African Wild Cat
Caracal caracal	Caracal
Order ARTIODACTYLA	
Raphicerus campestris	Steenbok
Raphicerus melanotis	Cape Grysbok

The total amphibian, reptile and mammal diversity of the study area were compared with those of the BNP. It was found that 12 of these vertebrates (three amphibians, four reptiles and five mammals) were only found in the study area. Results are given in figure 3.

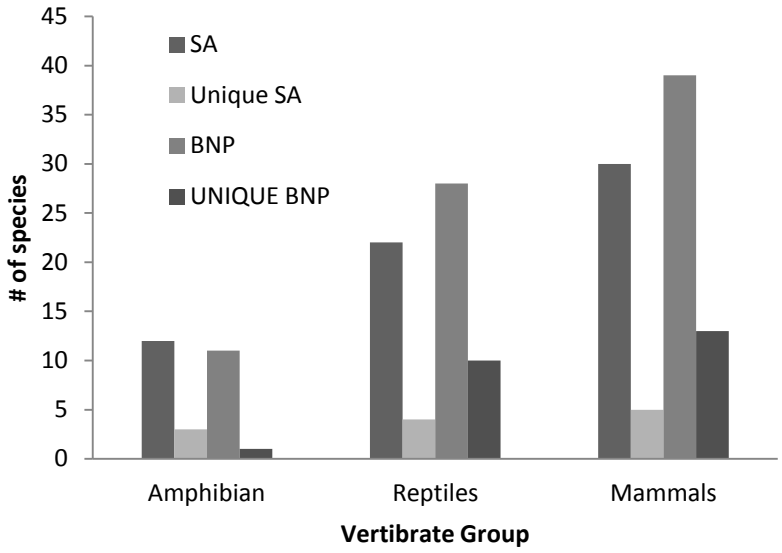

Figure 3.1 Comparison of the amphibian, reptile and mammal diversity recorded in the study area (SA) with that of Bontebok National Park (BNP). The number of species unique to a site is also given.

The vertebrates of RSR previously were poorly known, with earlier studies focusing on the larger Overberg and its parks. Braack (1981) mentioned 28 reptiles and 11 amphibian species in BNP. Seventeen reptiles and nine frogs are shared with the study area here.

All 122 bird species recorded in the study area are also present in BNP (Baron, 1981). The BNP contains more habitat types and may be more bird friendly than the study area. It also had more birders visiting it and will have a more complete list.

Birds are known to interact with other organisms in different ways. Many prey on invertebrates and small vertebrates. Others feed on the seeds of grasses as well as berries of certain shrubs. Renosterveld does not support as many berry-bearing plants as Strandveld, but there are a few in the area, including *Searsia*, *Asparagus*, *Chrysanthemoides monilifera* and *Olea europaea*, which are all bird dispersed (pers. observ.). The aloes in the area also provide food for nectar feeding birds in the winter time.

The BNP contains large mammal species that today are not found wild in the area. Mountain Zebra (*Equus zebra zebra*) and Bontebok (*Damaliscus dorcas dorcas*) occur now only in the BNP. The smaller antelopes like Bushbuck (*Tragelaphus scriptus*), Grey Rhebok (*Pelea capreolus*), Common Duiker (*Sylvicapra grimmia*), Steenbok (*Raphicerus campestris*) and Cape Grysbok (*R. melanotis*) however, do occur in the study area.

The Striped Mouse (*Rhabdomys pumilio*) and Vleirat (*Otomys irroratus*) are the most numerous rodents in the area (pers. observ. and trapping). Their runways are visible in areas where longer grasses occur. The Striped Mouse also uses heaps of dead native *Acacia* branches for hiding and for nesting. Cape and Olive House Snakes (*Boaedon capensis* and *B. olivaceus*) occur in the study area, and are known predators of these rodents (Branch, 1998). Their young hunt geckoes and small skinks until they are large enough to eat rodents (Branch, 1998). The Ocellated Thick-toed Gecko (*Pachydactylus geitjie*) is the only gecko species that occurs beneath rocks in the area, and might well fall prey to House Snake juveniles. Cape Skink (*Mabuya capensis*) juveniles may also be preyed upon. This skink is the most numerous lizard species in the study area. It may also be a prey item for the Rhombic Skaapsteker (*Psammophylax rhombeatus*) and Cross-marked Grass Snake (*Psammophis crucifer*) (Branch, 1998).

The Red-lipped Snake (*Crotaphopeltis hotamboeia*) has become the most abundant snake species in the area. It is a back fanged snake that feeds primarily on frogs (Branch, 1998). The apparent great increase in the Painted Reed Frog (*Hyperolius marmoratus*) in the area in the past five years is possibly due to introduction by humans. Delalande's Beaked Blind Snake (*Rhinotyphlops landei*) was found beneath rocks in the area. It is a small borrowing snake that feeds on termites (Branch, 1998), here a *Trinervitermis* species. Only one Spotted Harlequin Snake (*Homoroselaps lacteus*) was observed during this study, although in fact, it may be more common as it is cryptic, being mostly underground and in termite nests. It is known to be the main predator of Delalande's Beaked Blind Snake (Branch, 1998).

The Cape Eagle Owl bred at the study site and it, as well as the numerous and alien Barn Owl individuals as determined by their nocturnal calls. Pellets were found beneath the roosts of the two owls, and the rodent skulls therein were of the Vleirat (Stuart & Stuart, 1992). The remains of small birds are also found in these pellets.

Molerats (*Cryptomys capensis* and *C. hottentotus*) were in the less rocky areas and where geophytes were present, and did not occur at sites that had been heavily grazed. They feed on roots and tubers of grasses and bulbs. They were mostly active where bulbs were numerous.

Old Mole Rat tunnels provided hiding places for two baboon spider species (Figure 3.1; Plate 3.1). The presence of these spiders can be ascertained by the presence of silk-lined tunnels beneath rocks and bushes (Dippenaar-Schoeman, 2002). They are nocturnal and hunt for large invertebrates and even small vertebrates like geckos and mice. These spiders are endemic to the Cape (Dippenaar-Schoeman, 2002). Rain spiders (*Palystes* species) are common, nocturnal spiders, and their glimmering eyes can be spotted at night using a torch. Community Nest Spiders (*Stegodyphus dumicola*) (Figure 3.2; Plate 3.1) were also found between shrubs in the Renosterveld. They build messy, debris-filled nests with many individuals.

The Porcupine (*Hystrix africaeaustralis*) was found to be resident in the area. They were often seen where they borrow for Arum Lily (*Zantedeschia aethiopica*) bulbs in wetter areas. They also dig for the bulbs of Iridaceae as well as for the tubers of some *Euphorbia* species in the area. They do not have any natural predators left in the area and are hunted by farmers as they are seen as pest animals. The quills are used for adornment and the meat is also eaten. The Arum lily also provides food, in terms of its berries, for the Cape Weaver (*Ploceus capensis*). In turn, the flowers provide hiding places for the Arum lily and Painted Reed Frogs, and the plant is a host for the Common Striped Hawk Moth (*Hippotion eson*) (see below).

3.3.2 Invertebrates

A total of 214 insect families in 23 insect orders were recorded in the study area. Most families were in the Diptera, Coleoptera, Lepidoptera, Hemiptera and Hymenoptera (Figure 3.3).

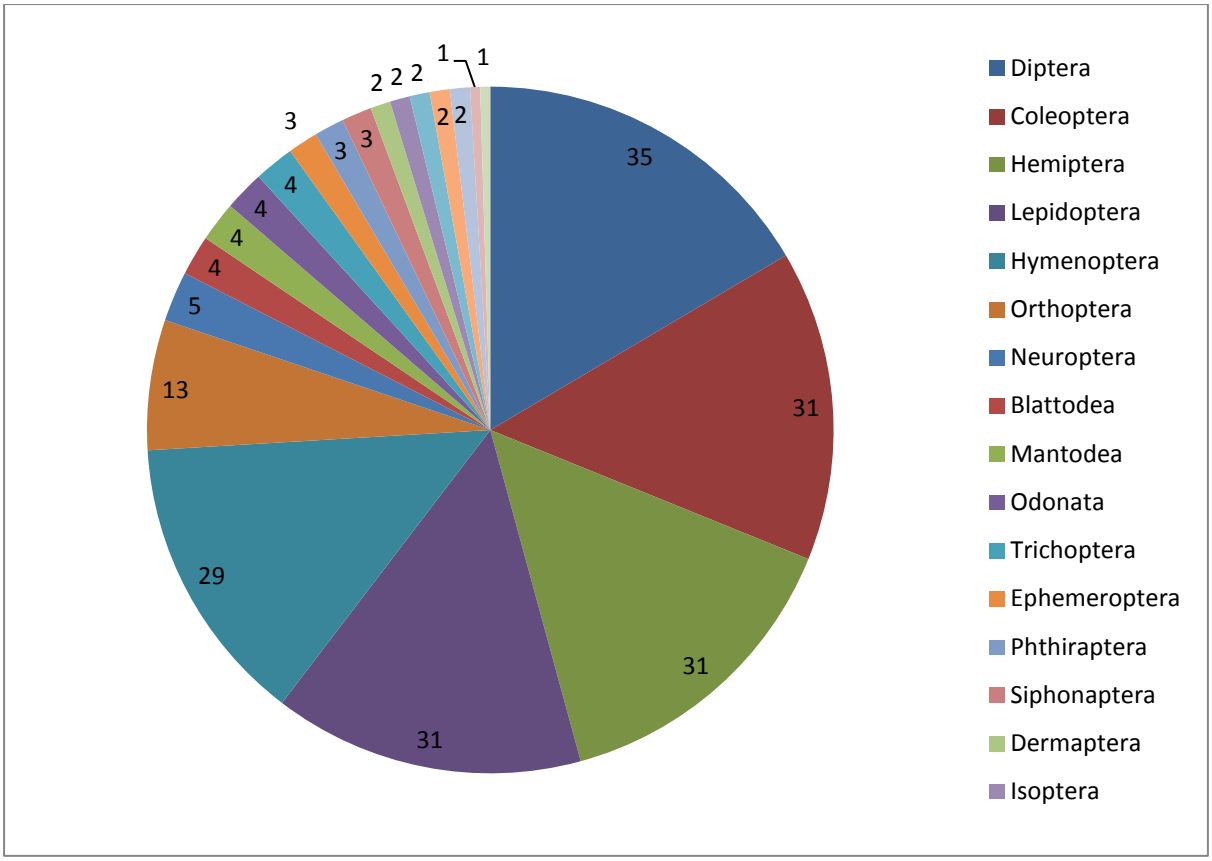

Figure 3.3: Number of insect families per order recorded in the study area.

a. Lepidoptera

Almost a hundred Lepidoptera species were recorded and identified to at least family level (Table 3.5). Some were reared from caterpillars or other immature stadium. Possible host plants that occur in the study area were also identified.

Following on from Pinhey (1975), I found at least 11 species with range expansions, probably due to previous under-recording. A total of 18 Lepidoptera species previously recorded from the Eastern Cape (Taylor 1949, 1951), were also recorded here. About five new moth species to science were also recorded here. In addition, 18 butterfly species were recorded during the study.

Table 3.5: Checklist of all Lepidoptera species recorded in the study area. Lepidoptera were identified as far as possible. Possible host plants that occur in the study area are also noted. Note that there are some that feed on debris.

Family	Subfamily	Species	Common name	Possible host plant/food
Adelidae	Nematopogoninae	*Ceromitia* sp.	Longhorn	
Adelidae	Nematopogoninae		Longhorn	
Alucitidae		*Alucita*	Many-plume moth	
Arctiidae	Arctiinae	*Utetheisa pulchella*	Speckled Footman	Poaceae, varied
Arctiidae	Arctiinae	*Paralacydes vocula*	Ermine	*Ledebouria ovatifolia, Albuca*
Arctiidae	Arctiinae	*Estigmene linea*	Streaked Ermine	Poaceae
Arctiidae	Arctiinae	*Estigmene emniscata*		
Arctiidae	Arctiinae	*Rhodogastria amasis*	Tri-coloured Tiger	*Arctotis discolor*
Arctiidae	Ctenuchinae	*Amata* sp. (new?)	Maiden	*Serruria acrocarpa*
Arctiidae	Lithosiinae	*Lithosia similipuncta*	Footman	Lichen
Arctiidae	Lithosiinae	*Siccia caffra*	Speckle-grey Footman	*Searsia glauca*
Cecidosidae		*Scyrotis athlete*		*Searsia glauca*
Cossidae	Zeuzerinae	*Phragmatoecia rufescens?*	Brindled Goat	*Acacia karroo, Salix*
Crambidae	Crambinae	*Chilo* sp.	Grass Moth	Poaceae
Eupterotidae	Eupterotinae	*Phiala costipuncta*	Dotted Phiala	Poaceae
Eupterotidae	Eupterotinae	*Phyllalia patens*	Clay Monkey	Poaceae
Geometridae	Ennominae	*Argyrophora trophonia*	Diamond Studs	*Erica*
Geometridae	Ennominae	*Semithiosa*	Peacock	*Acacia karroo*
Geometridae	Geometrinae	*Rhadinomphax divincta*	Two Phase Emerald	
Geometridae	Sterrhinae	*Rhodometra sacraria*	Vestal	*Rumex*

Geometridae				
Geometridae				*Acacia karroo*
Geometridae				
Hepialidae		*Eudalaca ammon*	Crooked Swift	Poaceae
Hepialidae		*Eudalaca* sp.		
Hepialidae				
Hesperiidae	Hesperiinae	*Gegenes niso*	Common Hottentot Skipper	Poaceae, *Themeda*, *Pennisetum clan*.
Lasiocampidae	Gonometinae	*Gonometa postica*	African Silkworm	*Acacia karroo*
Lasiocampidae	Gonometinae	*Anadiasa punctifascia*	Chestnut Eggarlet	*Acacia karroo*
Lasiocampidae	Lasiocampinae	*Mesoscelis monticola*	Mountain White Spot	*Aspalathus*
Lasiocampidae	Lasiocampinae	*Beralade p.perobliqua*	Oblique Eggarlet	*Acacia karroo*
Lasiocampidae	Lasiocampinae	*Streblote cristata*	Crested Nadiasa	*Leonotis ocymifolia*
Lasiocampidae	Lasiocampinae	*Eutricha capensis*	Cape Lappet	*Acacia karroo*, *Searsia glauca*
Lasiocampidae	Malacosomatinae	*Bombycomorpha bifascia*	Barred Eggarlet	*Searsia glauca*
Limacodidae	Limacodinae	*Latoia latistriga*	Broad Banded Latoia	*Prunus*
Limacodidae	Limacodinae	*Crothaema decorata*	Decorated Crothaema	*Gymnosporia buxifolia*
Lycaenidae	Polyommatinae	*Anthene definita definita*	Common Hairtail	*Acacia karroo*, *Searsia glauca*
Lycaenidae	Polyommatinae	*Lampides boeticus*	Lucerne Blue	*Medicago sativa*
Lycaenidae	Theclinae	*Chrysoritis chrysaor*	Burnished Opal	*Acacia karroo*
Lycaenidae	Theclinae	*Phasis thero thero*	Silver Arrowhead	*Searsia glauca*
Lymantriidae		*Bracharoa dregei*	Brown Vapourer	*Osteospermum*
Lymantriidae		*Dasychira octophora*	Eight Spot Tussock	*Lichen*

Lymantriidae		*Laelia figlina*	Red Streaked Laelia	Poaceae
Noctuidae	Acontiinae	*Rhodotarache roseofusca*	Barred Rose	
Noctuidae	Acronyctinae	*Daseochaeta verbenata*	Moss Brocade	*Clutia*
Noctuidae	Amphipyrinae	*Euplexia augens*	Clouded Arches	*Pelargonium*
Noctuidae	Amphipyrinae	*Spodoptera littoralis*	Tomato Moth	varied
Noctuidae	Amphipyrinae	*Spodoptera cilium*	Cape Lawn Moth	Poaceae
Noctuidae	Catocalinae	*Cuneisigna obstans*	Long Triangle	
Noctuidae	Catocalinae	*Cyligramma latona*	Cream Striped Owl	*Acacia karroo*
Noctuidae	Catocalinae	*Cortyta canescens*	Wavy Shades	*Acacia karroo*
Noctuidae	Catocalinae	*Grammodes exclusiva*	Black and White Lines	*Polygonum*
Noctuidae	Catocalinae	*Grammodes stolida*	Stolid Lines	*Tribulus terrestris*
Noctuidae	Chloephorinae	*Earias insulana*	Insular Bollworm	*Hermannia*
Noctuidae	Cuculliinae	*Klugeana* sp.(new?)	Oxalis Moth	*Oxalis*
Noctuidae	Cuculliinae	*Cucullia* sp.		*Pentzia, Osteospermum*
Noctuidae	Hadeninae	*Brithys crini*	Lily Leaf Miner	Amaryllidaceae
Noctuidae	Hadeninae	*Diaphone eumela*	Cherry Spot	*Albuca*
Noctuidae	Heliothinae	*Helicoverpa armigera*	Scarce Bordered Straw	varied
Noctuidae	Noctuinae	*Agrotis spinifera*	Spiny Cutworm	varied
Noctuidae	Plusiinae	*Syngrapha circumflexa*	Circumflex	*Solanum*
Noctuidae	Plusiinae	*Trichoplusia orichalcea*	Golden Plusia	varied
Noctuidae	Plusiinae	*Chrysodeixis acuta*	Silver U	*Solanum*
Nymphalidae	Danainae	*Danaus chrysippus aegyptius*	African Monarch	*Stapelia hirsuta, Gomphocarpus cancellatus*

Nymphalidae	Heliconiinae	*Acraea horta*	Garden Acraea	*Kiggelaria africana*
Nymphalidae	Heliconiinae	*Acraea rahira rahira*	Marsh Acraea	*Polygonum aviculare*
Nymphalidae	Nymphalinae	*Hypolimnas misippus*	Diadem	*Portulaca oleracea*
Nymphalidae	Nymphalinae	*Junonia hierta cebrene*	Yellow Pansy	*Barleria pungens*
Nymphalidae	Nymphalinae	*Cynthia cardui*	Painted Lady	*Arctotheca calendula*
Nymphalidae	Satyrinae	*Dira clytus clytus*	Cape Autumn Widow	Poaceae
Nymphalidae	Satyrinae	*Tarsocera cassus cassus*	Spring Widow	*Hyparrhenia hirta*
Oecophoridae	Oecophorinae	*Schiffermuelleria pedicata*	Acacia Gall Moth	*Acacia karroo* galls
Papilionidae	Papilioninae	*Papilio demodocus*	Citrus Swallowtail	*Citrus*
Papilionidae	Papilioninae	*Papilio nireus*	Green Swallowtail	*Citrus*
Pieridae	Coliadinae	*Catopsilia florella*	African Migrant	*Sesbania*
Pieridae	Pieridae	*Belenois aurota*	Brown-veined White	Capparidaceae
Pieridae	Pieridae	*Pieris brassicae*	Cabbage White	Brassicaceae
Pieridae	Pieridae	*Pontia helice helice*	Meadow White	Brassicaceae
Prototheoridae		*Prototheora cooperi*		Debris
Psychidae		*Kotochalia junodi*	Wattle Bagworm	*Acacia karroo*
Pterophoridae				Asteraceae
Pyralidae	Phycitinae	*Cactoblastis cactorum*	Prickly Pear Moth	*Opuntia ficus-indica*
Pyralidae	Phycitinae	*Dysphylia viridella*	Lichen Knothorn	*Gymnosporia buxifolia*
Pyralidae	Phycitinae	*Ectomyelois ceratoniae*	Carob Moth	*Acacia galls*
Pyralidae	Phycitinae	*Euzophera cullinanensis*	Knothorn	*Acacia karroo galls*
Saturniidae	Saturniinae	*Imbrasia tyrrhea*	Zigzag Emperor	*Acacia karroo*

Scythrididae		*Eretmocera laetissima*	Joyful moth	*Athanasia trifurcata*
Sesiidae	Sesiinae	*Synanthedon platyuriformis*	Dark Clearwing	*Searsia glauca*
Sphingidae	Macroglossinae	*Macroglossum t. trochilus*	African Humming Bird Hawk	Rubiaceae
Sphingidae	Macroglossinae	*Hippotion celerio*	Silver Striped Hawk	*Zantedeschia aethiopica*
Sphingidae	Macroglossinae	*Hippotion eson*	Common Striped Hawk	*Zantedeschia aethiopica*
Sphingidae	Sphinginae	*Agrius convolvuli*	Convolvulus Hawk	Convolvulaceae
Sphingidae	Sphinginae	*Acherontia atropos*	Death's Head Hawk	Privet
Thyretidae		*Automolis*		Poaceae
Thyretidae		*Thyretes caffra*	Bar Maiden	*Acacia karroo*
Tineidae	Hapsiferinae	*Cimitra* sp.		Woody debris
Tineidae				Woody debris
Tineidae				Woody debris
Tortricidae	Olethreutinae	*Cryptophlebia leucotreta*	Citrus Codling Moth	*Acacia* galls
Tortricidae	Olethreutinae	*Cryptophlebia peltastica*	Litchi Moth	*Acacia* galls
Tortricidae	Olethreutinae	*Lobesia stericta*		*Acacia* galls
Tortricidae	Tortricinae	*Epichoristodes* sp. (new?)		*Haworthia groenewaldii*, varied
Zygaenidae				*Gymnosporia buxifolia*

The most common species was the Cape Autumn Widow (*Dira clytus clytus*) which feed as larvae on the dominant grass species in the area *Themeda triandra*, *Hyparrhenia hirta* and *Digitaria eriantha*. Also common was the African Monarch (*Danaus chrysippus aegyptius*). Its distinctive larvae were found feeding on members of the Apocynaceae (Figure 3.4; Plate 3.1) (*Gomphocarpus cancellatus* (Figure 3.4 a; Plate 3.1.), *G. fruticosus* and *Stapelia hirsute* (Figure 3.4 b; Plate 3.1).

The Painted Lady, *Cynthia cardui* (Figure 3.5; Plate 3.2) was the only butterfly that was found throughout the year. Its caterpillars were found feeding on weedy thistles in the study area. This species is known to be cosmopolitan (Picker *et al*., 2003).

At least 10 Lepidoptera species that were recorded in the study area have larvae that feed on grasses. The largest of these are *Phyllalia patens*. *Phiala costipuncta* (Figure 3.6; Plate 3.2) is a grass eating moth in the same family as *P. patens*. Their caterpillars are nocturnal and can be found in winter and spring. *Diaphone eumela* (Figure 3.7; Plate 3.2) is another species of moth whose caterpillars were found in large numbers in the study area. It feeds on members of the Hyacinthaceae, and in the study area it fed on *Albuca canadensis*, *Drimia capensis* and various *Lachenalia* species.

Spiny black and red larvae (*Amata* sp. Ctenuchinae, Arctiidae) (Figure 3.8; Plate 3.3) fed on *S. ludwiggi* leaves (Figure 3.9; Plate 3.3). They were collected on two occasions and reared to adults in the laboratory. Females emerged first, and all had reduced wings and cannot fly. They were all from the second batch of larvae that were collected. The larvae that were collected first emerged >1week after the second batch, and were all males with normal wings. Ten species of *Amata* have been recorded in South Africa. A new species to science was found here, and still needs to be described. This species was also later found to eat numerous plants in the study area: *Passerina corymbosa*, *Struthiola ciliata, Asparagus capensis*, *Babiana patula* (Figure 3.10; Plate 3.3) and *Heterolepis peduncularis*. Another new moth species (*Epichoristodes* sp.) was found eating the flowers and green seedpods of *H. groenewaldii*. It belongs to the Tortricidae family and is related to the agricultural pest *E. acerbella* (Pear Leaf Roller).

b. Orthoptera

A total of 20 Orthoptera species were recorded during the study using the 50 m x 50 m search method. Another 27 species were recorded during visual searches (Table 3.6).

Table 3.6: Orthoptera species recorded in the study area. Species sampled in quadrants are marked with *.

Orthoptera Family/Species	*Common name*
Anostostomatidae	
	King crickets
Gryllacrididae	
Gryllacrididae sp.	Leaf-rolling crickets
Tettigoniidae	
Tylopsis sp.	Grass Katydid
Ruspolia sp.	Cone-headed Katydid
Gryllidae	
Gryllus bimaculatus	Common Garden Cricket
Cophogryllus sp.	Mute Cricket
Oecanthus capensis	Cape Tree Cricket
Platygryllus sp.	
Gryllotalpidae	
Gryllotalpa africana	Mole Cricket
Tridactylidae	
Xya sp.	Pygmy Mole Cricket
Tetrigidae	
Tetiella sp.	Groundhopper
Pneumoridae	
Bullacris intermedia	Bladder Grasshopper
Physemacris variolosus	Silver-spotted Bladder Grasshopper
Pamphagidae	
Lamarckiana sp.	Rain Locust
Pamphagidae sp.	Klipspringkaan
Pyrgomorphidae	
Phymateus leprosus	Green milkweed Locust
Phymateus morbillosus	Milkweed Locust
Dictyophorus spumans	Rooibaadjie
Ochrophlebia sp.	
Lentulidae	
Devylderia sp.	

Acrididae	
Acanthacris ruficornis	Garden Locust
Acrida acuminata	Common Stick Grasshopper
*Acrotylus furcifer**	Burrowing Grasshopper
*Acrotylus patruelis**	Burrowing Grasshopper
*Aiolopus meruensis**	
*Aiolopus thalassinus thalassinus**	
*Calliptamicus antennatus**	
*Calliptamicus semiroseus**	
Catantops sp.	
Conistica saucia	Rock Grasshopper
*Cyrtacanthacris aeruginosa**	
*Cyrtacanthacris tatarica**	
*Eyprepocnemis calceata**	
*Gastrimargus crassicollis**	
*Gastrimargus determinatus vitripennis**	
*Gymnobothrus carinatus**	
*Gymnobothrus linea-alba**	
*Gymnobothrus temporalis**	
*Heteropternis couloniana**	
*Oedaleus flavus flavus**	Yellow Wings
*Oedaleus nigrofasciatus**	Yellow Wings
Paracinema tricolor	Vlei Grasshopper
*Pnorisa squalus**	
*Sphingonotus nigripennis**	
Truxaloides sp.	
*Vitticatantops humeralis**	

Grasshoppers are extensively used as indicator species in grasslands, parks and even agricultural areas (Bazelet & Samways, 2010). Grasshoppers are easy to sample with nets in grasslands, as large areas have the same (grassy) structure and the ground is not too rocky. One can easily secure a grasshopper specimen in such vegetation. RSR, on the other hand, is a totally different terrain, with a substrate of boulders and hard and thorny vegetation. The height of the vegetation in certain areas is also to low. However, some species like, *Acrida acuminata* and the *Gastrimargus* species are known to prefer longer grass (Picker *et al*., 2002), and were only found at such sites. The heavily grazed *Cynodon* grass fields supported small grasshopper species like *Acrotylus furcifer* and *Aiolopus meruensis*. The genus *Oedaleus* can be and were found in areas with spare grass cover (Picker *et al*., 2002). Areas where the vegetation was very sparse (and/or rocky), supported species with brightly coloured hind wings (*Sphingonotus nigripennis* and *Conistica saucia*). These species were well camouflaged against the rocky substrate, but were easily spotted as they flew off. *C.*

saucia has bright red and *Sphingonotus nigripennis* dark bluish, hind wings, and are known to display from large rocks (Picker *et al*., 2002).

The four Pyrgomorphidae species are all brightly coloured, slow-moving species. These grasshoppers are poisonous and get their poison from feeding on milkweeds (Picker *et al*., 2002). *Dictyophorus spumans* is the slowest moving (and deadliest) of them all, and can sometimes aggregate around and totally defoliate members of the Amaryllis family.

3.3.3 Pollination

Some plants in the study area are pollinated by birds. These plants almost always have red or orange, tube-shaped flowers. Some of these include *Aloe ferox, A. maculata* (Figure 3.12; Plate 3.4), *Brunsvigia orientalis* (Amaryllidaceae) (Figure 3.13; Plate 3.4), *and Gladiolus teretifolius* (Iridaceae). *Watsonia aletroides* (Iridaceae) and *Lessertia frutescens* (Fabaceae) (Figure 3.14; Plate 3.4) are both bird pollinated. Of the above, *A. ferox* is the most numerous and can form dense stands. The four sunbird species are the main bird pollinators in the area but the weavers, especially the Cape Weaver (*Ploceus capensis*), and the Cape Bulbul (*Pycnonotus capensis*) also visit the flowers and may also pollinate the aloe plants. Bees, ants and wasps sometimes puncture holes at the base of the flower to steal the nectar (Smith & van Wyk, 2008). Certain red tubed *Erica* species have sticky flowers to deter ants from robbing its nectar (Schumann *et al*., 1992). Bees also collect the pollen without doing any pollination work. *Microloma sagittatum* (Apocynaceae) (Figure 3.15; Plate 3.4) is a small creeper in the milkweed family. It bares small pink to red flowers that do not have the long tube of other sunbird pollinated flowers. It has a unique way of spreading its pollen. It contains parcels of pollen that attach itself to the tongues of sunbirds (*Nectarinia* sps.). The bird then carries the parcel in its beak to the next flower where it detaches in the flower and pollinates it (Pauw, 1998).

More plants with long-tubed flowers occur in the area (*Cyrtanthus leptosiphon* (Amaryllidaceae) (Figure 3.16; Plate 3.5), *Tritonia pallida* (Figure 3.17; Plate 3.5) and *T. flabellifolia* (Iridaceae) (Figure 3.18; Plate 3.5). Unlike the bird-pollinated flowers, which are red and unscented, these flowers are light in colour and give off a scent. These flowers are pollinated by *Prosoeca longipennis*, a long-tongued fly species (Snyman, 1999). To date, I still have not recorded the fly in the study area. It may be that moths in the Sphingidae and/or Noctuidae families may also pollinate them at night.

Serruria ludwiggi is the only member of the Proteaceae that occurs in the study area. It is a re-sprouting, mat-forming shrub with greenish yellow pompom-like racemes. *Serruria ludwiggi* inflorescences give off a sweet vanilla smell and may be pollinated by moths at night or by other insects in the study area. Net wing beetles (*Lycus* sp., Lycidae) were found on the plants on more than one occasion, and may be pollinators of the plant (Figure 3.11; Plate 3.3). Net wing beetles were also found on the sweet smelling flowers of *Searsia* plants.

Some other plants in the study area also give of a sweet smell, but only at night. Examples of these plants can be found in the genus *Struthiola* (Figure 3.19; Plate 3.5). Most have light-coloured tube-shaped flowers. Two Iridaceae species in the area also fall into this group (*Lapeirousia pyramidalis* (Figure 3.20; Plate 3.5) and *Gladiolus maculatus*). *Gladiolus maculatus* is one of the 'Aandblom' species that are brown and scentless during the day and white and strong smelling at night. All of these flowers are pollinated by Sphingidae and/or Noctuidae moths at night.

Haworthia groenewaldii is a new plant species that is to date only known to occur in the study area. It is only known to be visited by the potential pollinators, a solitary bee species (*Amegilla falllax*, Anthophoridae) and a fly (*Australoechus hirtus*, Bombylliidae) but not by honey bees in the study area.

3.3.4 Interactions with selected plants

a. Acacia karroo

Nineteen insect species from 14 insect families in four orders were found in the study area to be associated with *A. karroo* trees (Table 3.7).

Table: 3.7: Insect species associated with *Acacia karroo* trees in the study area. The parts utilized by the insect were recorded (w, wood; s, seeds; l, leaves; f, flowers an; gr, green stems). Species marked with a star (*) are those that may use *A. karroo* trees as nesting sites.

Order/Family	Species	Common name	Parts used
Coleoptera			
Bostrichidae	Bostrichidae	Shot-hole Borer	w
Bruchidae	*Bruchus* sp.	Pea Weevil	s
Cerambycidae	*Ceroplesis thunbergii*	Pondo-pondo Longhorn	w

	Promeces sp.	Metallic Longhorn	w
	Zographus oculator	Orange-eyed Longhorn	w
Meloidae	Decapotoma lunata	Blister Beetle	f
Scarabaeidae	*Pachnoda sinuata*	Garden Fruit Chafer	f
Tenebrionidae	Tenebrionidae sp.	Darkling beetle	w
Hymenoptera			
Anthophoridae	*Xylocopa caffra**	Carpenter Bee	f
	*Ceratina nasalis**		w
Apidae	*Apis mellifera**	Honey Bee	f
		Peringuey's Cocktail	
Formicidae	*Crematogaster peringueyi**	Ant	l
Hemiptera			
Aphididae	Aphididae		gr
Coccidae	*Ceroplastes* sp.	Wax scale	gr
	Coccus hesperidum	Soft Brown Scale	gr
Lepidoptera			
Cossidae	*Phragmatoecia irrorata?*	Carpenter Moth	w
Geometridae			l
Lasiocampidae	*Anadiasa punctifascia*	Chestnut Eggarlet	l
	Eutricha capensis	Cape Lappet	l
	Gonometa postica	African Silkmoth	l

Acacia karroo is well known as a magnet for much animal life (Venter & Venter, 1996; Carr, 1976; Barnes *et al*., 1996). It is one of the most widespread trees in southern Africa (Barnes *et al*., 1996) and often grows were little else can be found. It is one of the largest and most numerous trees in the study area, and can form dense stands, especially in wetter gullies. It also invades disturbed or heavily grazed areas (Csurhes *et al*. 2010).

Imbrasia tyrrhea or Willow Emperor Moth (Figure 3.21; Plate 3.6.) of the Saturnidae is the largest moth in the area. Larvae emerge in large numbers in late summer, and in some years, can defoliate most *A. karroo* trees in certain stands. This defoliation does not kill the trees

and they re-sprout with new leaves within a few weeks after the larvae have left and have pupated in the soil (New, 1984).

In some years, the trees do not provide enough food for the larvae to reach their maximum size. They then tend to move over onto other plant species in the area (Figures 3.22-3.25; Plate 3.7), which includes the *Searsia* species in the area, as well as alien *Acacia* species like *A. mearnsii* and *A. cyclops*. The pupae provide food for ground birds like the Cape Francolin (*Pternistes capensis*) and Helmeted Guinea fowl (*Numida meleagris*), as well as for the Small Grey Mongoose (*Galerella pulverulenta*) (pers. observ.), which dig them out from beneath the trees.

The Guinea Fowl (*Numida meleagris*) uses large *A. karroo* trees as roosts at night. This leads to an accumulation of dung beneath the trees. This dung provides food for Diptera and Coleoptera larvae. A darkling beetle species (Tenebrionidae) was found living in this bird dung. Another Tenebrionidae species was found living in the loose, rotten wood inside a hollow in a dead tree.

Soil samples taken from beneath the trees contained a large number of entomopathogenic nematodes that may also kill of some pupae in the soil. Larvae of Tachinidae flies were also found to parasitize the pupae. The larvae and adult moths were also preyed apron by the Fiscal Shrike (*Lanius collaris*), Bokmakierie (*Telophorus zeylonus*) and other insectivorous birds in the area. The Fiscal Shrike builds its cup-shaped nest (Figure 3.26; Plate 3.8) in the thorn trees and uses the thorns as hooks to store prey as well as to help with tearing larger vertebrate prey into smaller pieces. The adult moths emerge in summer to mate, lay eggs and then die. The eggs are laid in a small ball on the tip of lower tree branches. Some egg "patches" are totally parasitized by *Mesocomys pulcriceps*, a small parasitic wasp in the Eupelmidae.

The caterpillars of four Lasiocampidae moth species, whose larvae feed on *A. karroo*, were found in the study area. They are the Cape Lappet (*Eutricha capensis*), African Silkmoth (*Gonometa postica*) (Figure 3.27; Plate 3.8), Oblique Eggarlet (*Berarade perobliqua*) and the Chestnut Eggarlet (*Anadiasa punctifascia*).

Adult Chestnut Eggarlet individuals were caught at night with light traps. The larvae (Figure 3.28; Plate 3.8) are gregarious and mass together in the daytime, only moving and feeding at night (Taylor, 1949; pers. observ.). They spin a tough, oval cocoon covered in brown

stinging hairs that rub off easily. Some larvae were collected on the trees and reared to maturity. A Tachinidae fly was bred out of some on the collected larvae. Taylor (1949) also found a Tachinidae and two Ichneumonidae species parasitizing *A. punctifascia*. Of the 61 cocoons obtained from the collected larvae, 50 tachinid fly individuals were obtained, while only eight were viable for adult moth emergence, and three of uncertain viability. The larvae of *A. punctifascia* can sometimes be found feeding together with *I. tyrrhea* (Figure 3.29; Plate 3.9).

Gonometa postica is not found in large numbers on the trees. It spins silken cocoons (covered with their irritation hairs) on the stems of the tree. In certain parts of Africa, these cocoons are collected in the veld to produce wild silk (Veldtman, 2005). They also are known to kill livestock were there pupae occur in large numbers and are mistaken for Acacia pods (Zumpt, 1971) but such large numbers were not recorded in the study area. The egg parasite *Mesocomys pulcriceps* is also known to attack *G. postica* eggs (Veldtman, 2005) but no eggs were found in the study area.

Another Lepidoptera species that fed on *A. karroo* in the area is the Burnished Opal (*Chrysoritis chrysaor*, Lycaenidae) whose larvae feed on the leaves and their pupae are tended by Peringuey's Cocktail Ants (*Crematogaster peringueyi*, Formicidae) (Woodhall, 2005). These ants also builds their nests in *A. karroo* trees and may also live in hollow thorns (pers. observ.; New, 1984). The trees also possess extra floral nectaries which secrete a sweet substance on which the ants feed (Palmer *et al*. 2008). The trees use ants for protection against herbivores, as they attack anything that tries to eat the leaves (New, 1984). They also farm Wax Scales (*Ceroplastes* sp.), Soft Brown Scales (*Coccus hesperidum*) (both Coccidae), as well as with soft bodied Aphididae that occur on the trees (Carr, 1976; pers. observ.). The ants protect and move the scales around in exchange for honeydew produced by them (Picker *et al.* 2002; pers. observ.).

Bar-throated Apilis (*Apalis thoracica*) and Cape White-eye (*Zosterops capensis*) were commonly observed hunting for aphids and small insects in the thorn trees. The Cape White-eye, weavers, Cape Bulbul (*Pycnonotus capensis*) and Pied Starling (*Spreo bicolour*) were seen feeding on Mistletoe (*Viscum* sp.) and may be responsible for spreading it between thorn trees (Castley *et al.* 2001; pers. observ.).

Acacia karroo is not long lived, and older trees tend to become brittle and easily damaged by wind (Barnes *et al*., 1996). This damage causes trees to be invaded by fungi and wood-eating

insects. Three longhorn beetle species (Cerambycidae) breed in these dying trees: the Orange-eyed longhorn (*Zographus oculator*) (Figure 3.30; Plate 3.9), Pondo-Pondo Longhorn (*Ceroplesis thunbergii*) and a *Promeces* sp. The larvae bore into the wood, and with the help of fungi (pers. comm. F. Roets), feed on it. Wood is not highly nutritious, and it takes up to two years for these larvae to complete their lifecycle.

Shot-hole borers (Bostrichidae) are another wood-boring coleopteran group that can sometimes be found in dead *A. karroo* wood. Dry-wood Termite (*Bifiditermes durbanensis*) also feeds and lives in the dying or dead trees. *Bantua* sp. (Blattodea) is an endemic cockroach (Picker *et al.* 2002) that can be found living under the loose pieces of bark. *Xylocopa caffra* (Carpenter Bee) and *Ceratina nasalis* also hollow out dead branches of the thorn trees to use for breeding.

These insects provide food to Acacia Pied barbet (*Tricholaema leucomelas*), Olive woodpecker (*Dendropicos griseocephalus*) and Cardinal Woodpecker (*D. fuscescens*). They also make it easier for these bird species to hollow trees out for nest. Woodpecker nests are sometimes taken over by the Whoop-whoop. It was also observed that Acacia Pied Barbet nests are sometimes parasitized by the Lesser Honey Guide, *Indicator minor*.

Acacia karroo seeds are sometimes infested by weevils (Bruchidae) that destroy the seeds. These are most likely a *Bruchus* species (Coates Palgrave, 1990). They are also eaten by various birds in the area, especially birds in the finch/weaver family. These include House and Cape Sparrows (*Passer domesticus* and *P. melanurus*), Southern Masked and Cape weavers (*Ploceus velatus* and *P. capensis*), Yellow, Bully, Cape and Streaky-headed canaries (*Serinus flaviventris, S. sulphuratus, S. canicollis* and *S. gularis*). These birds also use the trees as safe nesting sites. The Diederik Cuckoo (*Crysococcyx caprius*) parasitizes the weaver birds that nest in the trees. They are also one of the few birds that hunt Lasiocampidae caterpillars in the area.

The Gymnogene (*Polyboroides typus*) can sometimes be seen hunting chicks of the birds that use *A. karroo* trees as nesting place. They are even capable of catching chicks of the various Woodpecker species and other hole breeding birds, by inserting there long legs into the holes.

Acacia karroo produces a mass of flowers each year. These are a rich source of nectar and pollen for honeybees, *Apis mellifera* (Apidae) (Coates Palgrave, 1990; pers. observ.). They also nest in tree hollows and use the trees for resting places when travelling. The Garden

Fruit Chafer (*Pachnoda sinuata*) (Carr, 1976) and Blister Beetles (Meloidae) were found here eating the flowers, but they may also help with pollination. Red-faced and Speckled Mousebirds (*Urocolius indicus* and *Colius striatus*) were also found eating the flowers and leaves of the trees.

New (1984) mention 41 different galls from African Acacia species, four cauline, 13, axillary, 17 foliage and seven inflorescence/fruit galls. Of these, 29 were of unknown cause. Two inflorescence/fruit gall types were recorded here on *A. karroo*. The one type forms a round gall (similar to *Trichilogaster* galls on *A. longifolia*) in the region of the remains of the flower bud. Another gall is highly misshaped and appears to be caused by the rust fungus, *Ravenelia macowaniana*. The larger galls were infested by larvae of the Litchi Moth (*Cryptophlebia peltastica*), which was also found in fugal galls of *Acacia saligna* and wasp galls of *A. pycnantha* in the study area. Other moths bred out of the galls of *Acacia* in the study area included *Schiffermuelleria pedicata* and *Euzophera cullinanensis*.

Axillary galls were found on certain trees and a Pteromalidae wasp was bred out of them. They are known to form axillary galls on *Acacia* trees (New, 1984). A *Eupelmus* species was bred out of stem and axillary galls found on certain trees. They are usually hyperparasitoid (Veldtman *et al*. 2011) that infest the galls after it has been parasitized by another wasp. Here it most likely parasitizes certain Pteromalidae species.

b. *Searsia glauca*

Thirty-four insect species from 25 Insect families in six insect orders were recorded interacting with *Searsia glauca* (table 3.8).

Table 3.8: Insect species associated with *Searsia glauca* in the study area. The parts utilized by the insect are given (w, wood; l, leaves; fl, flowers; gr, green stems and br, branch).

Order/Family	Species	Common name	Parts used
Coleoptera			
Bostrichidae	Bostrichidae	Shot-hole Borer	w
Cerambycidae	*Promeces* sp.	Metallic Longhorn	w
Lycidae	*Lycus* sp.	Net-winged beetles	fl
Diptera			
Calliphoridae	*Chrysomya chloropyga*	Copper-tailed Blowfly	fl
	Chrysomya albiceps	Banded Blowfly	fl

Syrphidae	*Eristalis crassipes*	Drone Fly	fl
Hymenoptera			-
Eupelmidae	*Eupelmus* sp.1		br
Formicidae	*Crematogaster peringueyi**	Cocktail Ants	l
Pompilidae	*Tachypompilus ignites*	Spider-hunting Wasp	fl
Cynipidae	*Rhoophilus loewi*		br
Vespidae	*Polistes fastidiotus*		br
	Ropalida sp.		br
Hemiptera			-
Aphididae	Aphididae		gr
Coccidae	*Ceroplastes* sp.	Wax Scale	gr
	Coccus hesperidum	Soft Brown Scale	gr
Lepidoptera			
Arctiidae	*Lithosia similipuncta*	Footman	
	Siccia caffra	Specklegrey Footman	l
Cecidosidae	*Scyrotis athlete*		l
Cossidae	*Phragmatoecia irrorata?*	Carpenter Moth	w
Lasiocampidae	*Eutricha capensis*	Cape Lappet	l
	Bombycomorpha bifascia	Barred Eggarlet	l
Lycaenidae	*Anthene definita*	Common Hairtail	l
	Phasis thero thero	Silver Arrowhead	l
Saturniidae	*Imbrasia tyrrhea*	Zigzag Emperor	l
Sesiidae	*Synanthedon platyuriformis*	Dark Clearwing	l
Orthoptera			
Acrididae	*Acantacris ruficornis*	Garden Locust	br
	Gasstrimargus sps.		br
	Catantops sp.		br
Gryllidae	*Oecanthus* sp.	Tree cricket	br
Lentulidae	*Devylderia* sp.		br
Pneumoridae	*Physemacris variolus*	Bladder Grasshopper	br
Pyrgomorphidae	*Phymateus leprosus*	Green milkweed Locust	br
	Phymateus morbillosus	Milkweed Locust	br
Tettigoniidae	*Ruspolia* sp.	Katydid	br

Searsia glauca is a dense evergreen shrub or tree to 4 m that occurs in the Western and Eastern Cape (Vlok & Schutte-vlok, 2010). It has bluish grey trifoliate leaves and shiny, elliptic berries that are about 5 mm wide (Vlok & Schutte-vlok, 2010). The flowers are unisexual and found on separate plants. The male flowers have a strong, pungent sweet odour.

Birds observed in the study area feeding on *S. glauca* include the Red-faced and Speckled Mousebirds (*Urocolius indicus* and *Colius striatus*), Pied and Wattled starlings (*Spreo bicolour* and *Creatophora cinerea*), Cape White-eye (*Zosterops capensis*), Cape Bulbul (*Pycnonotus capensis*), and the Weavers Birds (*Ploceus velatus* and *P. capensis*).

These above mentioned birds like perching on fence lines and the seeds in their faeces fall just below it. This leads to *S. glauca* dominated fence lines that are not acceptable to many farmers, which use herbicides to be rid of these plants. This is detrimental to the local biodiversity, as it reduces some of the indigenous cover. These '*S. glauca* hedges' are sometimes the only natural vegetation found around cultivated land and provide shelter for many animals. These hedges may also provide corridors for the movement of certain animals between patches of natural vegetation but this still needs to be proven.

The Barred Eggarlet, *Bombycomorpha bifascia* (Lasiocampidae) feeds on the leaves of *S. glauca* (Figure3.31; Plate 3.10). Larvae also attack peppertrees *Schinus* species, invading exotic tree species that also belong to the Anacardiaceae family, like *Searsia*. The larvae are covered in irritating white, orange and black hairs that protect them against predators (Picker et al., 2002). These larvae move in groups on the plants and may totally defoliate the whole bush. After the larvae are about two months old, they reach their final size and move down from the plants and seek areas under rocks to construct their cocoons. The cocoons are about 20 mm long, hard and light brown colour. As with most Lasiocampidae species, they do not feed as adults and their sole purpose is to find mates and reproduce, living on the nutrients they obtained during the larval stage. Adult longevity is about a week.

Imbrasia tyrrhea larvae also sometimes feed on *S. glauca* plants. This usually happens when the *A. karroo* trees are totally defoliated by the larvae. It also feeds on the exotic *Acacia* species in the area.

Scyrotis athlete (Cecidosidae) is a small, drab moth that forms leaf and stem galls on *S. glauca* leaves (Meyrick, 1909). If the galls are opened, a larva can be found inside. When the larvae are done feeding on the gall, the gall pops open and the hard insides fall to the ground. Here the moth completes it metamorphosis.

Initially it was thought that the galls on *S. glauca* were formed by a cynipid wasp, *Rhoophilus loewi*, but it was then found that the wasp is just a parasitoid of the moth (Janse, 1920). The wasp's larvae take over the galls, eat the moth larvae, and form a solid gall. *Eupelmus* sp. 1

was another parasitic wasp that was reared out of the galls in the lab. It could be a parasitoid of the moth or it may be a hyperparasitoid, living off *R. loewi*.

The nine Orthoptera species found on *S. glauca* did not necessarily feed on the plants. Only three species were found nibbling on the leaves: the Garden Locust (*Acantacris ruficornis*), and the Common and Green Milkweed Locusts (*Phymateus morbillosus* and *P. leprosus* (Figure 3.32; Plate 3.10)). Most of the Orthoptera species use the shrubs as resting places and mating call perches. *Physemacris various, Ruspolia* spp. and *Oecanthus* sp. can be found calling from the plants at night-time. *P. various* only starts calling late at night (Picker *et al*. 2002).

An adult metallic green longhorn, *Promeces* sp. (Cerambycidae) was also found inside a dead *S. glauca* branch. They are sometime found on the male flowers of *S.glauca* plants. They are also attracted to other sweet smelling flowers in the area like, *Gymnosporia buxifolia*.

Viscum capense (Figure 3.33; Plate 3.10) is a parasitic plant sometimes found on *S. glauca*. Its white berries are spread by fruit-eating birds like *P. capensis*. Another species is sometimes found on the branches of *A. karroo*.

The *S. glauca* plants in the area are not healthy and are dying (Figure 3.34; Plate 3.10) from an unknown cause. The plants seem to die from the ground up and the affected plants are usually covered with dense lichen. These lichens are fed on by the moth larvae of *Lithosia similipuncta*.

3.4 Conclusion

The study area proved to contain not just high plant diversity (about 480 species), but a high animal diversity as well. The bird diversity (122 species) was found to be high for the study area if compared to Bontebok National Park (186 species (Baron, 1981), which is not just larger but contains more habitat types than the study area. The other (small) vertebrates studied compare well with that found in the Bontebok National Park, only the large game is absent from the study area. Some species found in the study area are absent from the Park. The insects found in the study area could not be compared to BNP because the park does not have a list.

This was also the first proper study to record the invertebrate diversity for the area. Insect families and orders seem to be well represented in this area and this list will only increase as more studies are done. Insect species that may be new to science, as well as species with range extensions, were recorded to occur in this study area. There is a good chance that more invertebrate species will be discovered. Lepidoptera can be a useful tool in predicting what plants can be found in the area, as there larvae only feed on specific plant families and even just one plant species in that family. The two woody species focused on in this study (*A. karroo* and *S. glauca*) were found to contain allot of organisms interacting with them. This may be due to the fact that they are the two dominant tree species found in the area. They may contain allot more interaction with other organisms, not noted in this study and may prove to be keystone species for this area.

The other 480 or so plants species will support a high and unique animal diversity. The varied nature of the veld in the study, caused by different management regimes or natural factors, may be another main reason for the high invertebrate diversity of area. It is thus important to conserve and manage the veld in such a way that the structure and plant diversity don't deteriorate, as this may lead to a loss of other organisms.

This data will be very useful for any future studies done on the surrounding remnants of RSR as well for the Bontebok National Park as they don't have much data of the insects that occur in the area.

Chapter 4: Conclusions and recommendations

4.1 Importance of the area and this study

As almost 80% of Rûens Silcrete Renosterveld, has been severely disturbed by ploughing (Mucina & Rutherford, 2006), the remaining remnants must be conserved. The RSR area in the Mullersrus district is one of the larger patches that still exist. It contains more than 400 plant species of which at least 25 are on the IUCN Red List. One plant species, *Haworthia groenewaldii* occur nowhere else in the world.

This patch of RSR also contains a rich invertebrate diversity, where many new species were recorded (see Chapter 3). Indeed, 214 insect families in 23 insect orders were found to occur in the study area. The fact that the RSR is also connected to thicket and riverine vegetation implies a network of corridors for these invertebrates.

The RSR patches that remain have been poorly studied, while this study increases the knowledge we have about this remaining Critically Endangered Vegetation type. The area also falls in the buffer zone of the Bontebok National Park, an area rated as a Critical Biodiversity Area, Priority Natural Area and a Viewshed Protected Area (BNPMP, 2012). As such, the overall area is of great conservation concern. The study area here forms a corridor that connects natural RSR and Alluvial vegetation in Buffeljagsrivier with larger Eastern Rûens Shale Renosterveld areas next to the Breëde River.

This is the first biodiversity inventory done on the Renosterveld in the Mullersrus area. The study area was found to contain very high plant and animal diversity. The lists compiled for this area are the most complete list to date and are important for making management decisions. South African National Biodiversity Institute's plant list for the 3420BA map area was found lacking even in the common species. The insect lists here are also the first for the larger Swellendam area.

The study found that different grazing regimes affected both plant structure and plant composition in the different camps. Different grazing levels amongst of the camps, contributes to making the whole area more heterogeneous, and may have allowed the high biodiversity to persist in the area. The known geographical range of some plants and insects has extended to include this area. A new plant species and a few new moth species to science were found in the study area. These species may be endemic to the area. More than thirty plant species were found to be of conservation concern.

4.2 Threats to RSR in Buffeljagsrivier area

4.2.1 Ploughing

Ploughing is the greatest threat to RSR. NEMA (National Environmental Management Act) controls the cultivation of virgin soil. It is illegal to plough any area that has not been cultivated for 10 years and longer, without a permit. To obtain a permit one needs to undertake an Environmental Impact Assessment (EIA). The EIA will not allow any development as the National Environmental Management Act of 1998 (NEMA) also states that it is illegal to cultivate vegetation that is classified as Critically Endangered, although currently there is still on-going loss of the natural systems in the area.

The study done in this area will hopefully help to show the stakeholders how important the area is for conservation and that it needs to be protected.

4.2.2 Grazing

Overgrazing is another threat to the vegetation in the area. Some areas have been overgrazed for many years. This has led to the loss of grass cover in certain areas and to the formation of Renosterbos and *Cliffortia* dominated veld. The wrong grazing regime and/or the lack of fire have shifted large areas of the vegetation toward a type of thicket. These thickets are dominated by thorny shrubs and trees. Thickets are good for the area's biodiversity but it is not as rare as RSR and cannot be used for grazing.

4.2.3 Invaders

Alien plants are also invading certain areas of veld but they are not as prominent yet. The main invaders are grasses like, *Lolium multiflorum, Cynodon dactylon* and *Pennisetum clandestinum*. These grasses may smother geophytes and other grasses in the wetter areas. *Pennisetum setaceum* does occur on a neighbouring farm and may become a serious invader if it not eradicated.

Other invaders that need to be monitored are the Australian acacias. *Acacia cyclops*, *A. mearnsii*, *A. saligna* and *A. pycnantha* all occurring in the study area, and may become a threat to the veld if not managed correctly.

4.2.4 Rock/gravel

Rocks and gravel were excavated from the study area in the past for the building of Buffeljagsrivier's Irrigation System. There has also been removal of gravel in the past decade for road repair. This has left a permanent scar in veld. The topsoil has been removed and all that is left is a very loose rocky substrate. Only the weedy grass species, *Melinis repens* and the shrub, *Athanasia trifurcate* have been able to grow on this substrate.

4.3 Recommendations

4.3.1 No ploughing

We cannot afford to lose any more of this unique vegetation type and ploughing of virgin RSR should be stopped. The old fields surrounding the study area should also be left intact to provide a buffer between the cultivated land and the RSR patches. It is also recommended that isolated patches be connected to larger areas through corridors (Samways, 2006). This can be done by not ploughing strips of cultivated land between sites.

4.3.2 Grazing management

Grazing should be better managed in the area. The overgrazed camp should be rested for a few years to allow native grasses to set seed and multiply. Grass seeds from neighbouring camps can also be sown into this area.

4.3.3 Burning

Arcardia is the only farm in the study area that will benefit from fire at the moment. It is dominated by the climax grass *Merxmuellera disticha*. This grass is known to be an indicator of old Renosterveld that needs burning. Burning should be done in autumn just before the rains starts (Raitt, 2005). It will promote the flowering of bulbs as well as the growth and spread of more palatable grasses. It will also rejuvenate re-sprouting shrubs and put nutrients into the ground.

This site contains about thirty specimens of the Critically Endangered, *Wiborgiella bowieana*, and by burning, the new plant may come up from the seed bed. The old plants may also re-sprout new healthy shoots after the fire.

This camp also contains the largest population of *Haworthia groenewaldii* and it is not certain what the effect of fire will have on it.

4.3.4 Reserve

The biodiversity of this area is unique, and the area large enough to consider the establishment of a protected area or a conservancy. It contains species and habitats not found in BNP and by conserving it, more of the areas biodiversity will be represented in protected areas. It could be an arrangement between the owners themselves or between them and Cape Nature. If a reserve is not an option, Cape Nature can at least help the farmers to manage the area. They can help with providing advice on when to graze as well when to burn certain parts.

4.4 Use of the information obtained

Most of the objectives were met in this study. The information collected in this study will be useful to other research done in the natural areas surrounding the study areas, as well for other Renosterveld patches in the Overberg. The lists compiled will especially be useful for the BNP, as the study area falls within the parks different zoning and they do not know what plants or animals occur in it. The BNP do not have much information on the insects that occur in it and will find the insect lists compiled for this study area useful.

Most of the moths (and some other insect orders) collected are pinned and housed in the insect collection of Stellenbosch University. This collection can be used for further research as well as a reference for new collections made in the Overberg.

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Plates:

Plate 1.1

Figure 1.1

Figure 1.2

Figure 1.1: Old cultivated land that rested for around two years. Note the dominance of the grass *Melinis repens*.

Figure 1.2: Old cultivated RSR in the Buffeljagsrivier area, overgrown by *Cliffortia ruscifolia*.

Figure 1.5: Farm dam cut-out showing some of the characteristic soil layers of the area.

Plate 1.2

Figure 1.3

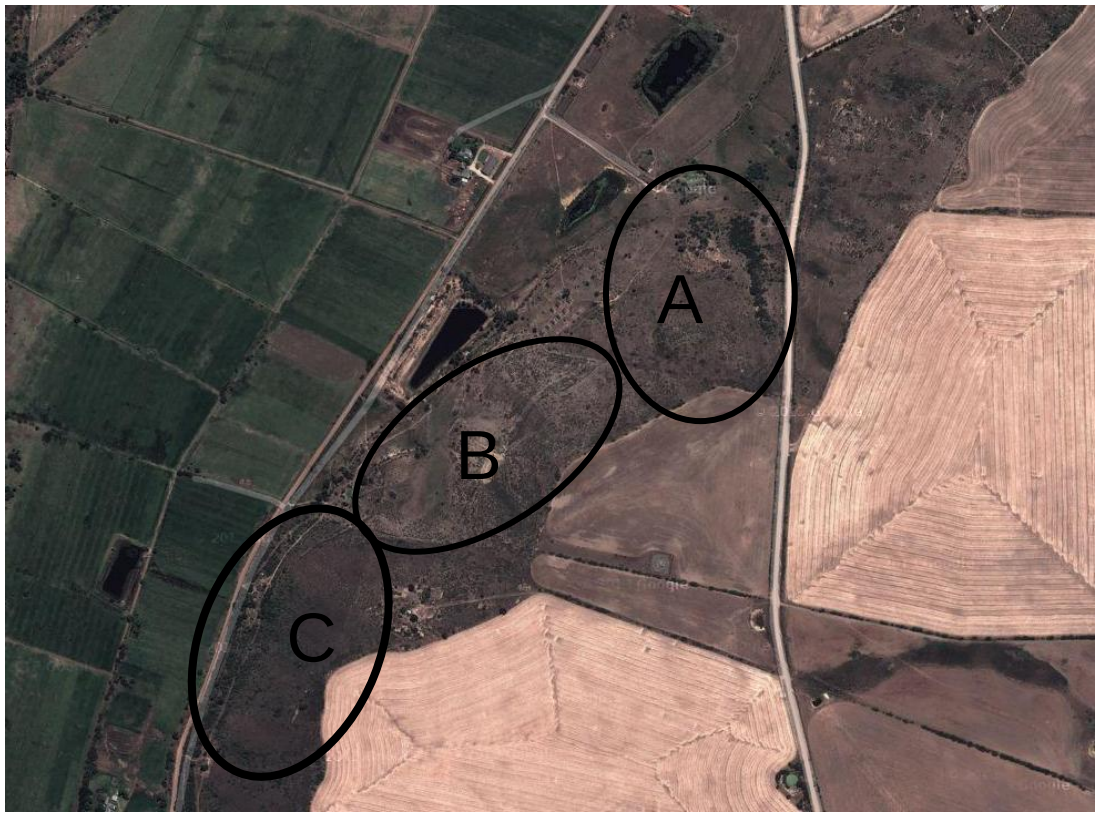

Figure 1.4

Figure 1.3-1.4: 1.3. Satellite image of Buffeljagsrivier and surrounding area; 1.4. This satellite image shows part of the Mullersrust district including the three farms, (A) Kelkiewyn, (B) Kromhout and (C) Arcardia, where the study was done. (Google Maps, 2013)

Plate 1.3

Figure 1.6

Figure 1.7

Figure 1.6: Well managed, medium grazed RSR on the farm Kelkiewyn
Figure 1.7: Overgrazed RSR on the farm Kromhout

Figure 1.8

Figure 1.9

Figure 1.8: Camp on the farm Arcadia that contains RSR that has not been grazed or burned for decades.
Figure 1.9: Thorny Thickets found on the farm Arcardia

Plate 2.1

Figure 2.1: Bontebok National Park (large circle) and the study area (small circle). Scale 1cm = ± 1km.

Figure 2.2: Medium grazed RSR

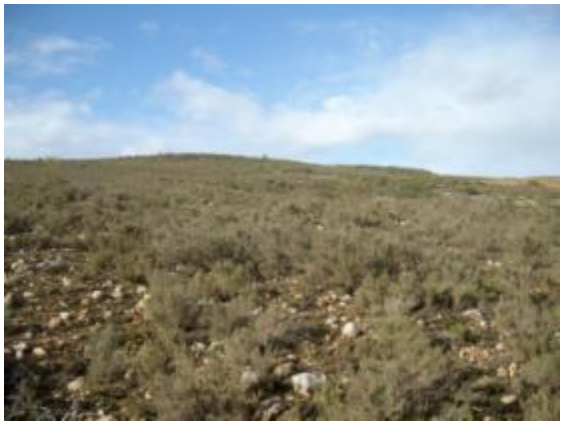

Figure 2.3: Heavily grazed RSR

Plate 2.2

Figure 2.10: ***Diosma fallax***

Figure 2.11: ***Haworthia groenewaldii***

Figure2.12: ***Wiborgiella bowieana***

Figure 2.13: ***Cyrtanthus leptosipho***

Plate 3.1

Figure 3.2: ***Harpactira* sp.**

Figure 3.3: *Stegodyphus dumicola*

Figure 3.5a

Figure 3.5b

Figure 3.5: a. African Monarch (*Danaus chrysippus aegyptius*) caterpillar feeding on *Gomphocarpus cancellatus;* b: African Monarch (*D.s c. aegyptius*) caterpillar feeding on *Stapelia hirsute*

Plate 3.2

Figure 3.6: Painted Lady (*Cynthia cardui*) feeding on the flowers of *Athanasia trifurcata*

Figure 3.7

Figure 3.8

Figures 3.7-3.8: 3.7. *Phiala costipuncta* larva feeding on *Cyperus textilis*; 3.8. *Diaphone eumela* larvae feeding on *Albuca canadensis*.

Plate 3.3

Figure 3.9

Figure 3.10

Figure 3.11

Figure 3.12

Figure 3.9-3.12: 3.9. *Amata* sp. larva; 3.10. Flowering *S .ludwiggi*; 3.11. *Amata* sp. larva feeding on *Babiana patula*; 3.12. Mating net wing beetles (*Lycus* sp., Lycidae) on the flowers of *S .ludwiggi*.

Plate 3.4

Figure 3.13

Figure 3.14

Figure 3.15

Figure 3.16

Figurs 3.13-3.16: Some bird pollinated plants found in the study area: 3.13. *Aloe maculata*; 3.14. *Brunsvigia orientalis*; 3.15. *Lessertia frutescens*; 3.16. *Microloma sagittatum*

Plate 3.5

Figure 3.17

Figure 3.18

Figure 3.19

Figures 3.17-3.19: Possible long-tongued, fly-pollinated flowers found in the study area: 3.17. *Cyrtanthus leptosiphon*; 3.18. *Tritonia pallid*; 3.19. *Tritonia flabellifolia*

Figure 3.20: *Struthiola*

Figure 3.21: *Lapeirousia pyramidalis*

Plate 3.6

Figure 3.22: Different life stages of *Imbrasia tyrrhea*. Top left is the male (note featherlike antennae and slender abdomen), top right is the female (slender antennae and large abdomen). Below are a pupa and a final instar larva.

Plate 3.7

Figure 3.23

Figure 3.24

Figure 3.25

Figure 3.26

Figures 3.23-3.26 *Imbrasia tyrrhea* feeding on different plants: .3.23 *Acacia karroo*; 3.24 *A. cyclops*; 3.25 *A. mearnsii*; 3.26 *Searsia* sp.

Plate 3.8

Figure 3.27: Nest of *Lanius collaris* found in an *A.karroo* tree

Figure 3.28

Figure 3.29

Figure 3.28-3.29 Lasiocampidae found feeding on *A.karroo*. 3.28 *G. postica*; 3.29 *A. punctifascia*

Plate 3.9

Figure 3.30: The larvae of *A. punctifascia* feeding together with *I. tyrrhea* on *A. karroo*

Figure 3.31: *Zographus oculator*

Plate 3.10

Figure 3.32

Figure 3.33

Picture 3.32-3.33 Insects that feeds on Searsia glauca: 3.32 *Bombycomorpha bifascia*; 3.33 *Phymateus leprosus*

Figure 3.34: *Viscum capense*

Figure 3.35: Dying *Searsia glauca*

Appendices

Appendix 1: Checklist of the plants found in Mullersrus

This checklist follows the same nomenclature and arrangement used by Kraaij (2011) for comparison the study area plants with those of the BNP.

Growth form: Cli, Climber; Dwa, Dwarf shrub; Geo, Geophytes; Gra, Graminoid; Her, Herb; Shr, Shrub; Suc, Succulent; Tre, Tree. Range: En, Endemic to Cape Floristic Region (Goldblatt and Manning, 2000); Ex, alien plant species (Bromilow, 2010)

Red List status (Raimondo et al., 2009):: CR, Critically Endangered; EN, Endangered; VU, Vulnerable; NT, Near Threatened; DD, Data Deficient – Taxonomically Problematic; LC, Least Concern; NE, Not Evaluated.

Taxon	Growth Form	Red Data Status	Range
Angiospermae			
Monocotyledonae			
Agavaceae			
Agave americana L.	Suc	NE	Ex
Agave sisalana Perrine	Suc	NE	Ex
Alliaceae			
Northoscordum gracile (Aiton) Stearn.	Geo	NE	Ex
Tulbaghia capensis L.	Geo	LC	En
Amaryllidaceae			
Boophone disticha (L.f.) Herb.	Geo	Declining	
Brunsvigia orientalis (L.) Aiton ex Eckl.	Geo	LC	
Crossyne guttata (L.) D. & U.Müll.-Doblies	Geo	LC	En
Cyrtanthus leptosiphon Snijman	Geo	CR	En
Gethyllis afra L.	Geo	LC	En
Gethyllis villosa (Thunb.) Thunb.	Geo	LC	
Haemanthus sanguineus Jacq.	Geo	LC	En
Nerine humilis (Jacq.) Herb.	Geo	LC	En
Strumaria spiralis L'Hér.	Geo	LC	En

Anthericaceae			
Chlorophytum undulatum (Jacq.) Oberm.	Geo	LC	
Aponogetonaceae			
Aponogeton distachyos L.f.	Geo	LC	En
Araceae			
Zantedeschia aethiopica (L.) Spreng.	Geo	LC	
Asparagaceae			
Asparagus aethiopicus L.	Cli	LC	
Asparagus africanus Lam.	Cli	LC	
Asparagus asparagoides (L) W.Wight	Cli	LC	
Asparagus capensis L. var. *capensis*	Shr	LC	
Asparagus densiflorus (Kunth) Jessop	Cli	LC	
Asparagus multiflorus Baker	Shr	LC	
Asparagus striatus (L.f.) Thunb.	Shr	LC	
Asphodelaceae			
Aloe hybrid	Suc	LC	
Aloe ferox Mill.	Suc	LC	
Aloe maculata All.	Suc	LC	
Bulbine cepacea (Burm.f.) Wijnands	Geo	LC	En
Bulbine mesembryanthoides Haw.	Geo	LC	
Bulbinella barkeriae P.L.Perry	Geo	LC	En

Haworthia groenewaldii I.Breuer	Suc	EN	En
Trachyandra sp.	Geo	LC	
Trachyandra revoluta (L.) Kunth	Geo	LC	
Colchicaceae			
Baeometra uniflora (Jacq.) G.J.Lewis	Geo	LC	En
Colchicum eucomoides (Jacq.) J.C.Manning & Vinn.	Geo	LC	
Cyperaceae			
C*yperus esculentus* L.	Gra	NE	Ex
Cyperus textilis Thunb.	Gra	LC	
Ficinia sp.	Gra	LC	En
Ficinia bulbosa (L.) Nees	Gra	LC	
Ficinia nigrescens (Schrad.) J.Raynal	Gra	LC	
Ficinia oligantha (Steud.) J.Raynal	Gra	LC	
Hellmuthia membranacea (Thunb.) R.W.Haines & Lye	Gra	LC	En
Mariscus tungbergii (Vahl) Schrad	Gra	LC	
Eriospermaceae			
Eriospermum graminifolium A.V.Duthie	Geo	LC	En
Eriospermum lanceifolium Jacq.	Geo	LC	En
Eriospermum paradoxum (Jacq.) Ker Gawl.	Geo	LC	
Eriospermum proliferum Baker	Geo	LC	
Eriospermum pubescens Jacq.	Geo	LC	En

Haemodoraceae			
Wachendorfia multiflora (Klatt) J.C. Manning & Goldblatt	Geo	LC	
Wachendorfia paniculata Burm.	Geo	LC	En
Hyacinthaceae			
Albuca canadensis (L.) F.M. Leight.	Geo	LC	
Albuca cooperi Baker	Geo	LC	
Albuca exuviata Baker	Geo	LC	
Albuca goswinii U.Mull.-Doblies	Geo	LC	En
Albuca suaveolens (Jacq.) J.C. Manning & Goldblatt	Geo	LC	
Albuca viscosa L.f.	Geo	LC	
Dipcadi brevifolium (Thunb.) Fourc.	Geo	LC	
Drimia capensis (Burman fil.) Wijnands	Geo	LC	
Lachenalia algoensis Schonland	Geo	LC	
Lachenalia attenuata W.F.Baker ex G.D. Duncan	Geo	LC	
Lachenalia orchioides (L.) Aiton var. *orchioides*	Geo	LC	En
Lachenalia perryae G.Duncan	Geo	LC	
Lachenalia unifolia Jacq.	Geo	LC	En
Ledebouria revoluta (L.f.) Jessop	Geo	LC	
Massonia echinata L.f.	Geo	LC	
Ornithogalum dubium Houtt.	Geo	LC	
Ornithogalum graminifolium Thunb.	Geo	LC	

Ornithogalum juncifolium Jacq. var. *juncifolium*	Geo	LC	
Ornithogalum thyrsoides Jacq.	Geo	LC	
Veltheimia capensis (L.) DC.	Geo	LC	
Hypoxidaceae			
Empodium gloriosum (Nel) B.L.Burtt	Geo	LC	
Hypoxis angustifolia Lam.	Geo	LC	
Hypoxis argentea Harv. Ex Baker	Geo	LC	
Hypoxis floccosa Baker	Geo	LC	
Spiloxene capensis (L.) Garside	Geo	LC	En
Spiloxene flaccida (Nel) Garside	Geo	LC	En
Spiloxene ovata (L.f.) Garside	Geo	LC	
Iridaceae			
Aristea pusilla (Thunb.) Ker Gawl.	Her	LC	
Babiana patersoniae L.Bolus	Geo	LC	
Babiana patula N.E.Br.	Geo	Declining	En
Babiana stricta (Aiton) Ker Gawl.	Geo	NT	En
Bobartia orientalis J.B.Gillett	Geo	LC	En
Chasmanthe bicolor (Gasp.) N.E.Br.	Geo	VU	En
Freesia caryophyllacea (Burm.f.) N.E.Br.	Geo	NT	En
Freesia fergusoniae L.Bolus	Geo	EN	En
Freesia leichtlinii Klatt subsp. *leichtlinii*	Geo	VU	En

Geissorhiza heterostyla L.Bolus	Geo	LC	
Geissorhiza ovata (Burm.f.) Asch. & Graebn.	Geo	LC	En
Gladiolus sp.	Geo	LC	
Gladiolus alatus L.	Geo	LC	En
Gladiolus carinatus Aiton	Geo	LC	En
Gladiolus engysiphon G.J.Lewis	Geo	VU	En
Gladiolus gracilis Jacq.	Geo	LC	En
Gladiolus maculatus Sweet	Geo	LC	
Gladiolus patersoniae F.Bolus	Geo	LC	En
Gladiolus stellatus G.J.Lewis	Geo	LC	En
Gladiolus teretifolius Goldblatt & M.P.de Vos	Geo	NT	En
Gladiolus virescens Thunb.	Geo	LC	En
Lapeirousia pyramidalis (Lam.) Goldblatt subsp. *pyramidalis*	Geo	LC	
Micranthus tubulosus (Burm.) N.E.Br.	Geo	LC	En
Moraea algoensis Goldblatt	Geo	LC	En
Moraea bulbillifera (G.J.Lewis) Goldblatt spp. *anomala*	Geo	LC	En
Moraea fergusoniae L.Bolus	Geo	LC	En
Moraea gawleri Spreng.	Geo	LC	
Moraea inconspicua Goldblatt	Geo	LC	
Moraea lewisiae Goldblatt	Geo	LC	
Moraea macronyx G.J.Lewis	Geo	LC	

Moraea miniata Andrews	Geo	LC	
Moraea neglecta G.J.Lewis	Geo	LC	En
Moraea setifolia (L.f.) Druce	Geo	LC	
Moraea tricuspidata (L.f.) G.J.Lewis	Geo	LC	
Moraea tripetala (L.f.) Ker Gawl.	Geo	LC	
Moraea virgata Jacq. subsp. *virgata*	Geo	LC	
Romulea atrandra G.J.Lewis var. *atrandra*	Geo	LC	
Romulea dichotoma (Thunb.) Baker	Geo	LC	En
Romulea flava (Lam.) M.P.de Vos var. *flava*	Geo	LC	En
Romulea jugicola M.P.de Vos	Geo	VU	En
Romulea luteoflora M.P.de Vos	Geo	LC	
Romulea minutiflora Klatt	Geo	LC	
Romulea rosea (L.) Eckl. var. *rosea*	Geo	LC	En
Romulea setifolia N.E.Br. var. *setifolia*	Geo	LC	
Tritonia flabellifolia (D.Delaroche) G.J.Lewis var. *flabellifolia*	Geo	LC	En
Tritonia pallida Ker Gawl. ssp. taylorae (L.Bolus) M.P.de Vos	Geo	VU	En
Watsonia aletroides (Burm.f.) Ker Gawl.	Geo	NT	En
Watsonia laccata (Jacq.) Ker Gawl.	Geo	LC	En
Juncaceae			
Juncus capensis Thunb.	Gra	LC	
Juncaginaceae			

Triglochin bulbosa L.	Gra	LC	
Menyanthacea			
Nymphoides thunbergiana (Griseb.) Kuntze	Geo	LC	
Ophioglossaceae			
Ophioglossum polyphyllum A.Braun	Geo	LC	
Orchidaceae			
Disa bracteata Sw.	Geo	LC	En
Holothrix secunda (Thunb.) Rchb.f.	Geo	LC	
Satyrium erectum Sw.	Geo	LC	
Poaceae			
Aristida diffusa Trin. subsp. *diffusa*	Gra	LC	
Aristida junciformis Trin. & Rupr. ssp. *junciformis*	Gra	LC	
Avena fatua L.	Gra	NE	Ex
Brachiaria serrata (Thunb.) Stapf	Gra	LC	
Briza maxima L.	Gra	NE	Ex
Briza minor L.	Gra	NE	Ex
Bromus catharticus Vahl	Gra	NE	Ex
Chloris gayana Kunth	Gra	LC	
Chloris gayana Kunth	Gra	NE	Ex
Cymbopogon marginatus (Steud.) Stapf ex Burtt Davy	Gra	LC	
Cynodon dactylon (L.) Pers.	Gra	LC	

Cynodon dactylon (L.) Pers.	Gra	NE	Ex
Digitaria eriantha Steud.	Gra	LC	
Ehrharta calycina Sm. var. *calycina*	Gra	LC	
Ehrharta erecta Lam. var. *erecta*	Gra	LC	
Ehrharta longiflora Sm.	Gra	LC	
Eragrostis capensis (Thunb.) Trin.	Gra	LC	En
Eragrostis curvula (Schrad.) Nees	Gra	LC	
Eragrostis obtusa Munro ex Ficalho & Hiern	Gra	LC	
Heteropogon contortus (L.) Roem. & Schult.	Gra	LC	
Hordeum murinum L. ssp. *glaucum* (Steud.) Tzvelev	Gra	NE	Ex
Hyparrhenia hirta (L.) Stapf	Gra	LC	
Lolium multiflorum Lam.	Gra	NE	Ex
Melinis repens (Willd.) Zizka subsp. *repens*	Gra	LC	
Merxmuellera stricta (Schrad.) Conert	Gra	LC	
Paspalum dilatatum Poir.	Gra	NE	Ex
Paspalum distichum L.	Gra	NE	Ex
Pennisetum clandestinum Hochst. ex Chiov.	Gra	NE	Ex
Pennisetum setaceum (Forssk.) Chiov.	Gra	NE	Ex
Pentameris curvifolia (Schrad.) Nees	Gra	LC	
Pentameris pallida (Thunb.) Galley & H.P.Linder	Gra	LC	
Phalaris minor Retz.	Gra	NE	Ex

Poa annua L.	Gra	NE	Ex
Polypogon monspeliensis (L.) Desf.	Gra	NE	Ex
Sporobolus africanus (Poir.) Robyns & Tournay	Gra	LC	
Themeda triandra Forssk.	Gra	LC	
Tribolium uniolae (L.f.) Renvoize	Gra	LC	En
Vulpia myuros (L.) C.C.Gmel.	Gra	NE	Ex
Restionaceae			
Calopsis burchellii (Mast.) H.P.Linder	Gra	LC	En
Ischyrolepis triflora (Rottb.) H.P.Linder	Gra	LC	
Tecophilaeaceae			
Cyanella hyacinthoides L.	Geo	LC	
Cyanella lutea L.f.	Geo	LC	
Typhaceae			
Typha capensis (Rohrb.) N.E.Br.	Gra	LC	
Dicotyledonae			
Acanthaceae			
Barleria pungens L.f.	Her	LC	
Blepharis capensis (L.f.) Pers.	Her	LC	
Aizoaceae			

Amaranthaceae			
Amaranthus deflexis L.	Her	NE	Ex
Galenia africana L.	Shr	LC	
Anacardiaceae			
Searsia sp.	Shr	LC	
Searsia glauca (Thunb.) Moffett	Shr	LC	
Searsia lucida (L.) F.A.Barkley forma *lucida*	Shr	LC	
Searsia pterota (C.Presl) Moffett	Shr	LC	En
Searsia pyroides Burch.	Shr	LC	
Searsia rosmarinifolia (Vahl) F.A.Barkley	Shr	LC	En
Apiaceae			
Arctopus echinatus L.	Her	LC	
Centella glabrata L	Her	LC	En
Annesorhiza triternata (Eckl. & Zeyh.) Vessio, Tilney & B-E.van Wyk	Her	LC	En
Apocynaceae			
Asclepias crispa P.J.Bergius var. *crispa*	Geo	LC	
*Asipdoglossum heterophyllum*E.Mey.	Cli	LC	
Brachystelma occidentale Schltr.	Geo	LC	En
Carissa bispinosa (L.) Desf. ex Brenan	Tre	LC	
Cynanchum obtusifolium L.f. var. *obtusifolium* L.f.	Cli	LC	En
Duvalia elegans (Masson) Haw.	Suc	VU	En

*Gomphocarpus cancellatus (*Burm.f.) Bruyns	Shr	LC	
Gomphocarpus fruticosus (L.) W.T.Aiton	Shr	LC	
Microloma sagittatum (L.) R.Br.	Cli	LC	
Pachycarpus dealbatus E.Mey.	Her	LC	
Sarcostemma viminale (L.) R.Br.	Cli	LC	
Stapelia hirsuta L. var. *hirsuta*	Suc	LC	
Asteraceae			
Arctotheca calendula (L.) Levyns	Her	LC	
Arctotis sp.	Her	LC	
Arctotis acaulis L.	Her	LC	
Arctotis discolor (Less.) Beauverd	Her	LC	En
Athanasia dentata (L.) L.	Shr	LC	En
Athanasia trifurcata (L.) L.	Shr	LC	En
Berkheya armata (Vahl) Druce	Her	LC	En
Berkheya rigida (Thunb.) Bolus & Wolley-Dod ex Adamson & T.M.Salter	Shr	LC	En
Bidens pilosa L.	Her	NE	Ex
Chrysanthemoides monilifera (L.) T. Norl.	Shr	LC	
Chrysocoma ciliata L.	Dwa	LC	
Cirsium vulgare (*Savi*) *Ten*.	Her	NE	Ex
Conyza bonariensis (L.) Cronq.	Her	NE	Ex
Conyza scabrida DC.	Her	LC	

Cotula turbinata L.	Her	LC	En
Cuspidia cernae (L.f.) B.L.Burtt	Her	LC	
Dicerothamnus rhinocerotis (L.f.) Koekemoer	Shr	LC	
Disparago ericoides (P.J.Bergius) Gaertn.	Dwa	LC	En
Eriocephalus africanus L. var. *paniculatus* (Cass.) M.A.N.Müll.,P.P.J.Herman & Kolberg	Shr	LC	
Euryops sp.	Shr	LC	
Felicia minima (Hutch.) Grau	Her	LC	
Galinsoga parviflora Cav.	Her	NE	Ex
Gazania krebsiana Less. subsp. *krebsiana*	Her	LC	
Gerbera crocea (L.) Kuntze	Her	LC	En
Gnaphalium declinatum L.f.	Her	LC	En
Gnaphalium pauciflorum DC.	Her	LC	
Gorteria personata L. subsp. *personata*	Her	LC	En
Helichrysum cochleariforme DC.	Dwa	NT	En
Helichrysum patulum (L.) D.Don	Dwa	LC	En
Helichrysum petiolare Hilliard & B.L.Burtt	Dwa	LC	
Helichrysum rosum (P.J.Bergius) Less. var. *rosum*	Dwa	LC	
Heterolepis peduncularis DC.	Dwa	LC	En
Hirpicium integrifolium (Thunb.) Less.	Dwa	LC	En
Hypochaeris radicata L.	Her	NE	Ex

Lactuca serriola L.	Her	NE	Ex
Macledium spinosum (L.) S.Ortíz	Dwa	LC	
Metalasia densa (Lam.) P.O.Karis	Shr	LC	
Metalasia muricata (L.) D.Don	Shr	LC	
Monoculus monstrosus (Burm.f.) B.Nord.	Her	LC	
Oedera genistifolia (L.) Anderb. & K.Bremer	Dwa	LC	
Oedera squarrosa (L.) Anderb. & K.Bremer	Shr	LC	En
Oligocarpus calendulaceus (L.f.) Less.	Her	LC	
Osteospermum hispidum Harv. var. *hispidum*	Her	Thr*	En
Osteospermum imbricatum L. ssp. *imbricatum*	Dwa	LC	
Othonna sp.	Her	LC	
Pentzia incana (Thunb.) Kuntze	Her	LC	
Picris echioides L.	Her	NE	Ex
Pseudognaphalium luteo-album	Her	NE	Ex
Pteronia hirsuta L.f.	Dwa	LC	En
Pteronia incana (Burm.) DC.	Shr	LC	
Pulicaria scabra (Thunb.) Druce	Her	LC	
Relhania garnotii (Less.) K.Bremer	Shr	VU	En
Rhynchopsidium sessiliflorum (L.f.) DC.	Her	LC	
Senecio toxois C.Jeffrey	Suc	LC	En
Sonchus asper (L.) Hill	Her	NE	Ex

Sonchus oleraceus L.	Her	NE	Ex
Stoebe capitata P.J.Bergius	Dwa	LC	
Tagetes minuta L.	Her	NE	Ex
Tripteris aghillana DC. var. *aghillana*	Her	LC	
Ursinia anthemoides (L.) Poir. subsp. *anthemoides*	Her	LC	
Ursinia anthemoides (L.) Poir. subsp. *variegata*	Her	LC	
Ursinia dentata (L.) Poir.	Her	LC	En
Ursinia nana DC. subsp. *nana*	Her	LC	
Vellereophyton dealbatum (Thunb.) Hilliard & B.L.Burtt	Her	LC	
Xanthium spinosum L.	Her	NE	Ex
Boraginaceae			
Lobostemon argenteus (P.J.Bergius) H.Buek	Dwa	LC	
Brassicaceae			
Capsella bursa-pastoris (L.) Medik.	Her	NE	Ex
Heliophila sp.	Her	LC	
Lepidium africanum (Burm.) DC.	Her	LC	
Raphanus raphanistrum L.	Her	NE	Ex
Rapistrum rugosum (L.) All.	Her	NE	Ex
Buddlejaceae			
Buddleja saligna Willd.	Tre	LC	
Cactaceae			

Opuntia ficus-indica (L.) Mill.	Suc	NE	Ex
Campanulaceae			
Monopsis lutea (L.) Urb.	Her	LC	En
Prismatocarpus fruticosus L'Hér.	Dwa	LC	En
Prismatocarpus pedunculatus (P.J.Bergius) A.DC	Dwa	LC	En
Wahlenbergia capensis (L.) A.DC.	Dwa	LC	En
Wahlenbergia cinerea (L.f.) Lammers	Dwa	LC	
Wahlenbergia parvifolia (P.J.Bergius) Lammers	Dwa	LC	En
Caryophyllaceae			
Cerastium capense Sond.	Her	LC	
Dianthus caespitosus Thunb.	Her	LC	En
Pollichia campestris Aiton	Dwa	LC	
Polycarpon tetraphyllum (L.) L. *tetraphyllum*	Her	NE	Ex
Silene gallica L.	Her	NE	Ex
Silene undulata Aiton	Her	LC	
Stellaria media (L.) Vill.	Her	NE	Ex
Celastraceae			
Gymnosporia buxifolia (L.) Szyszyl.	Tre	LC	
Chenopodiaceae			
Atriplex semibaccata R.Br. var. *appendiculata* Aellen	Her	LC	
Chenopodium album L.	Her	NE	Ex

Chenopodium carinatum R. Br.	Her	NE	Ex
Chenopodium murale L	Her	NE	Ex
Salsola sp.	Her	LC	
Commelinaceae			
Commelina africana L. var. *africana*	Her	LC	
Cyanotis speciosa (L.f)Hassk.	Her	LC	
Convolvulaceae			
Convolvulus capensis Burm.f.	Cli	LC	
Crassulaceae			
Bryophyllum delagoense (Eckl. & Zeyh.) Shinz	Suc	NE	Ex
Cotyledon orbiculata L. var. *orbiculata*	Suc	LC	
Crassula cotyledonis Thunb.	Suc	LC	
Crassula fallax Friedrich	Suc	LC	En
Crassula tetragona L. ssp. *tetragona*	Suc	LC	
Cucurbitaceae			
Cucumis myriocarpus Naudin.	Her	LC	
Dipsacaceae			
Scabiosa incisa Mill.	Her	LC	
Droseraceae			
Drosera cistiflora L.	Her	LC	
Ebenaceae			

Diospyros dichrophylla (Gand.) De Winter	Tre	LC	
Euclea undulata Thunb.	Tre	LC	
Ericaceae			
Erica sp.	Dwa	LC	En
Erica hispidula L. var. *hispidula*	Dwa	LC	En
Erica peziza Lodd.	Dwa	LC	En
Euphorbiaceae			
Acalypha capensis (L.F.) Prain & Hutch.	Suc	LC	
Euphorbia burmannii E.Mey. ex Boiss.	Suc	LC	
Euphorbia ecklonii (Klotzsch & Garcke) A.Hässl.	Suc	LC	En
Euphorbia inaequilatera Sond. var. *inaequilatera.*	Her	NE	Ex
Euphorbia mammilaris L.	Suc	LC	
Euphorbia mauritanica L.	Suc	LC	
Euphorbia mira L.C.Leach	Suc	LC	En
Euphorbia pseudoglobosa Marloth	Suc	VU	En
Euphorbia tuberosa L.	Suc	LC	
Ricinus communis L. var. *communis*	Shr	NE	Ex
Fabaceae			
Acacia cyclops A.Cunn. ex G.Don	Tre	NE	Ex
Acacia karroo Hayne	Tre	LC	
Acacia mearnsii De Wild.	Tre	NE	Ex

Acacia pycnantha Benth.	Tre	NE	Ex
Acacia saligna (Labill.) H.L.Wendl.	Tre	NE	Ex
Amphithalea ericifolia (L.) Eckl. & Zeyh. subsp. *erecta* Granby	Shr	CR	En
Aspalathus acuminata Lam. subsp. *acuminata*	Dwa	LC	
Aspalathus campestris R.Dahlgren	Dwa	VU	En
Aspalathus ciliaris L.	Shr	LC	En
Aspalathus cymbiformis DC.	Dwa	LC	En
Aspalathus mundiana Eckl. & Zeyh.	Dwa	LC	En
Aspalathus nigra L.	Dwa	LC	En
Aspalathus quinquefolia L. subsp. *virgata* (Thunb.) R.Dahlgren	Shr	LC	En
Aspalathus spinosa L. subsp. *flavispina* (C.Presl ex Benth.) R.Dahlgren	Dwa	LC	
Aspalathus submissa R.Dahlgren	Dwa	LC	En
Indigofera heterophylla Thunb.	Her	LC	
Indigofera nigromontana Eckl. & Zeyh.	Shr	LC	
Indigofera tomentosa Eckl. & Zeyh.	Her	LC	
Lebeckia simsiana Eckl. & Zeyh.	Dwa	LC	
Lessertia frutescens (L.) Goldblatt & JC Manning	Shr	LC	
Lotononis villosa (E.Mey.) Steud.	Her	VU	En
Lotononis umbellata (L.) Benth.	Her	LC	En
Lotus subbifloris Lag.	Her	NE	Ex
Medicago polymorpha L.	Her	NE	Ex

Otholobium candicans (Eckl. & Zeyh.) C.H.Stirt.	Shr	LC	
Podalyria myrtillifolia (Retz.) Willd.	Shr	LC	En
Tephrosia capensis (Jacq.) Pers. var. angustifolia E.Mey.	Her	LC	
Trifolium africanum Ser. var. *africanum*	Her	LC	
Trifolium angustifolium L.	Her	NE	Ex
Trifolium burchellianum Ser. subsp. *burchellianum*	Her	LC	
Trifolium repens L.	Her	NE	Ex
Trifolium stipulaceum Thunb.	Her	LC	En
Vicia sativa L.	Cli	NE	Ex
Wiborgiella bowieana (Benth.) Boatwr. & B.-E.van Wyk	Dwa	CR	En
Gentianaceae			
Sebaea aurea (L.f.) Roem. & Schult.	Her	LC	En
Geraniaceae			
Erodium moschatum (L.) L'H r.	Her	NE	Ex
Geranium incanum Burm.f.	Her	LC	
Pelargonium alchemilloides (L.) L'Hér.	Dwa	LC	
Pelargonium carneum Jacq.	Geo	LC	En
Pelargonium caucalifolium Jacq. subsp. *caucalifolium*	Dwa	LC	En
Pelargonium crispum (P.J.Bergius) L'Hér.	Dwa	LC	En
Pelargonium lobatum (Burm.f.) L'Hér.	Geo	LC	En
Pelargonium longifolium (Burm.f.) Jacq.	Geo	LC	En

*Pelargonium myrrhifolium (*L.) L'Hér. var. *coriandrifolium* (L.) Harv.	Dwa	LC	
Pelargonium odoratissimum (L.) L'Hér.	Dwa	LC	
Pelargonium pinnatum (L.) L'Hér.	Dwa	LC	En
Pelargonium triste (L.) L'Hér.	Geo	LC	
Hemerocallidaceae			
Caesia contorta (L.f.) T.Durand & Schinz	Her	LC	
Lamiaceae			
Salvia chamelaeagnea P.J.Bergius	Shr	LC	
Lobeliaceae			
Cyphia digitata (Thunb.) Willd. subsp. *digitata*	Cli	LC	
Cyphia linarioides C.Presl ex Eckl. & Zeyh.	Her	LC	
Cyphia volubilis (Burm.f.) Willd. var. banksiana E.Wimm.	Cli	LC	
Lobelia coronopifolia L.	Her	LC	En
Lobelia setacea Thunb.	Her	LC	En
Lobelia tomentosa L.f.	Her	LC	
Malvaceae			
Abutilon sonneratianum (Cav.) Sweet	Dwa	LC	
Hibiscus aethiopicus L. var. *aethiopicus*	Dwa	LC	
Hibiscus pusillus Thunb.	Dwa	LC	
Malva parviflora L.	Her	NE	Ex
Meliaceae			

Melia azedarach L.	Tre	NE	Ex
Menispermaceae			
Cissampelos capensis L.f.	Cli	LC	
Mesembryanthemaceae			
Acrodon subulatus(L.) N.E.Br.	Suc	EN	En
Carpobrotus acinaciformis (L.) L.Bolus	Suc	LC	
Carpobrotus edulis (L.) L.Bolus subsp. *edulis*	Suc	LC	
Cephalophyllum diversiphyllum (Haw.) H.E.K.Hartmann	Suc	NT	En
Delosperma macrostigma L.Bolus	Suc	DDT	En
Drosanthemum calycinum (Haw.) Schwantes	Suc	NT	En
Drosanthemum floribundum (Haw.) Schwantes	Suc	LC	
Drosanthemum hispidum (L.) Schwantes	Suc	LC	
Glottiphyllum depressum (Haw.) N.E.Br.	Suc	LC	
Lampranthus sp.	Suc	NT	En
Mesembryanthemum crystallinum L.	Suc	LC	
Ruschia lineolata (Haw.) Schwantes	Suc	LC	En
Trichodiadema gracile L.Bolus	Suc	LC	En
Trichodiadema strumosum (Haw.) L.Bolus	Suc	DDT	En
Molluginaceae			
Pharnaceum dichotomum L.f.	Her	LC	
Montiniaceae			

Montinia caryophyllacea Thunb.	Shr	LC	
Myrsinaceae			
Myrsine africana L.	Tre	LC	
Oleaceae			
Olea europaea L. subsp. *africana* (Mill.) P.S.Green	Tre	LC	
Oxalidaceae			
Oxalis caprina L.	Geo	LC	
Oxalis ciliaris Jacq.	Geo	LC	
Oxalis confertifolia (Kuntze) R.Knuth.	Geo	LC	
Oxalis corniculata L.	Geo	NE	Ex
Oxalis depressa Eckl. & Zeyh	Geo	LC	
Oxalis eckloniana C.Presl var. *sonderi* T.M.Salter	Geo	LC	En
Oxalis flava L. var. *flava*	Geo	LC	
Oxalis hirta L. var. *hirta*	Geo	LC	En
Oxalis latifolia Kunth.	Geo	NE	Ex
Oxalis luteola Jacq.	Geo	LC	En
Oxalis obtusa Jacq.	Geo	LC	
Oxalis pes-caprae L. var. *pes-caprae*	Geo	LC	
Oxalis polyphylla Jacq. var. *polyphylla*	Geo	LC	En
Oxalis punctate L.f.	Geo	LC	
Oxalis purpurea L.	Geo	LC	

Passifloraceae			
Passiflora coerulea L.	Cli	NE	Ex
Phytolaccaceae			
Phytolacca octandra L.	Shr	NE	Ex
Pittosporaceae			
Pittosporum viridiflorum Sims	Tre	LC	
Plantagaginaceae			
Plantago lanceolata L.	Her	NE	Ex
Polygalaceae			
Muraltia sp.	Dwa	LC	
Muraltia heisteria (L.) DC.	Dwa	LC	En
Muraltia pappeana Harv.	Dwa	NT	En
Polygala pubiflora Burch. Ex DC.	Dwa	LC	En
Polygala umbellata L.	Her	LC	En
Polygonaceae			
Polygonum aviculare L.	Her	NE	Ex
Rumex crispus L.	Her	NE	Ex
Portulacaceae			
Anacampseros lanceolata (Haw.) Sweet subsp. *nebrownii* (Poelln.) Gerbaulet	Suc	LC	
Portulaca oleracea L.	Suc	NE	Ex
Primulaceae			

Anagallis arvensis L.	Her	NE	Ex
Proteaceae			
Serruria acrocarpa R.Br.	Dwa	NT	En
Ranunculaceae			
Clematis brachiata Thunb.	Cli	LC	
Rhamnaceae			
Phylica ericoides L. var. *ericoides*	Dwa	LC	En
Rosaceae			
Cliffortia sp.	Dwa	LC	
Cliffortia ruscifolia L. var. *Ruscifolia*	Shr	LC	En
Rubiaceae			
Anthospermum prostratum Sond.	Dwa	LC	En
Rutaceae			
Agathosma ciliaris (L.) Druce	Dwa	LC	En
Diosma fallax I.Williams	Dwa	EN	En
Diosma passerinoides Steud.	Dwa	VU	En
Santalaceae			
Thesidium fragile (Thunb.) Sond.	Dwa	LC	
Thesium sp.	Her	LC	En
Sapindaceae			
Dodonaea viscosa Jacq. var. *angustifolia* (L.f.) Benth.	Tre	LC	

Sapotaceae			
Sideroxylon inerme L. subsp. *inerme*	Tre	LC	
Scrophulariaceae			
Chaenostoma hispidum (Thunb.) Benth.	Dwa	LC	
Chaenostoma uncinatum (Desr.) Kornhall	Dwa	LC	En
Diascia sp.	Her	NE	
Dischisma capitatum (Thunb.) Choisy	Her	LC	En
Dischisma ciliatum (P.J.Bergius) Choisy subsp. *ciliatum*	Dwa	LC	En
Freylinia undulata (L.f.) Benth.	Shr	LC	En
Manulea cheiranthus (L.) L.	Her	LC	En
Nemesia barbata (Thunb.) Benth.	Her	LC	
Selago sp.1	Dwa	LC	
Selago sp.2	Dwa	LC	
Selago geniculata L.f.	Dwa	LC	
Sutera foetida Roth	Dwa	LC	
Veronica persica Poiret.	Her	NE	Ex
Solanaceae			
Datura stramonium L.	Her	NE	Ex
Lycium cinereum Thunb.	Shr	LC	
Nicandra physalodes (L.) Gaertn.	Her	NE	Ex
Physalis viscosa L.	Her	NE	Ex

Solanum linnaeanum Hepper & Jaeger	Shr	LC	
Solanum mauritianum Scop.	Tre	NE	Ex
Solanum nigrum L.	Her	NE	
Solanum tomentosum L	Her	LC	
Sterculiaceae			
Hermannia	Dwa	LC	
Hermannia alnifolia L.	Dwa	LC	
Hermannia cuneifolia Jacq. var. *cuneifolia*	Dwa	LC	
Hermannia flammea Jacq.	Dwa	LC	
Hermannia saccifera (Turcz.) K.Schum.	Dwa	LC	
Thymelaeaceae			
Gnidia laxa (L.f.) Gilg	Dwa	LC	En
Passerina corymbosa Eckl. ex C.H.Wright	Shr	LC	
Struthiola sp.	Dwa	LC	
Struthiola argentea Lehm.	Shr	LC	
Struthiola ciliata (L.) Lam.	Shr	LC	
Struthiola tomentosa Andrews	Dwa	LC	En
Urticaceae			
Urtica urens L.	Her	NE	Ex
Verbenaceae			
Lantana camara L.	Shr	NE	Ex

Verbena bonariensis L.	Her	NE	Ex
Viscaceae			
Viscum capense L.f.	Dwa	LC	
Tiliaceae			
Grewia occidentalis L. var. *occidentalis*	Dwa	LC	
Zygophyllaceae			
Roepera pygmaeum Eckl. & Zeyh.	Dwa	LC	
Tribulus terrestris L.	Her	LC	

Appendix 2: Bird recorded in study area.

Species	Common name
Accipiter melanoleucus	Black Sparrowhawk
Acrocephalus gracilirostris	Lesser Swamp-Warbler
Alcedo cristata	Malachite Kingfisher
Alopochen aegyptiacus	Egyptian Goose
Amaurornis flavirostris	Black Crake
Anas erythrorhyncha	Red-billed Teal
Anas sparsa	African Black Duck
Anas undulata	Yellow-billed Duck
Anhinga rufa	African Darter
Anthropoides paradiseus	Blue Crane
Apalis thoracica	Bar-throated Apalis
Apus caffer	White-rumped Swift
Aquila verreauxii	Verreaux's Eagle
Ardea cinerea	Grey Heron
Ardea melanocephala	Black-headed Heron
Ardea purpurea	Purple Heron
Bostrychia hagedash	Hadeda Ibis
Bradypterus baboecala	Little Rush-Warbler
Bubo africanus	Spotted Eagle-Owl
Bubulcus ibis	Cattle Egret
Burhinus capensis	Spotted Thick-knee
Burhinus vermiculatus	Water Thick-knee
Buteo rufofuscus	Jackal Buzzard
Caprimulgus pectoralis	Fiery-necked Nightjar
Centropus burchellii	Burchell's Coucal
Ceryle rudis	Pied Kingfisher
Chalcomitra amethystina	Amethyst Sunbird
Charadrius tricollaris	Three-banded Plover
Chrysococcyx caprius	Diderick Cuckoo
Chrysococcyx klaas	Klaas's Cuckoo
Ciconia ciconia	White Stork

Cinnyris afer	Greater Double-collared Sunbird
Cinnyris chalybeus	Southern Double-collared Sunbird
Cisticola fulvicapilla	Neddicky Neddicky
Cisticola juncidis	Zitting Cisticola
Coccopygia melanotis	Swee Waxbill
Colius striatus	Speckled Mousebird
Columba arquatrix	African Olive-Pigeon
Columba guinea	Speckled Pigeon
Columba livia	Rock Dove
Corvus albicollis	White-necked Raven
Corvus albus	Pied Crow
Corvus capensis	Cape Crow
Cossypha caffra	Cape Robin-Chat
Coturnix coturnix	Common Quail
Crithagra albogularis	White-throated Canary
Crithagra flaviventris	Yellow Canary
Crithagra gularis	Streaky-headed Seedeater
Crithagra scotops	Forest Canary
Crithagra sulphuratus	Brimstone Canary
Cuculus solitarius	Red-chested Cuckoo
Delichon urbicum	Common House-Martin
Dendrocygna viduata	White-faced Duck
Dendropicos fuscescens	Cardinal Woodpecker
Dicrurus adsimilis	Fork-tailed Drongo
Egretta garzetta	Little Egret
Elanus caeruleus	Black-shouldered Kite
Estrilda astrild	Common Waxbill
Euplectes capensis	Yellow Bishop
Euplectes orix	Southern Red Bishop
Fulica cristata	Red-knobbed Coot
Gallinago nigripennis	African Snipe
Gallinula chloropus	Common Moorhen
Halcyon albiventris	Brown-hooded Kingfisher

Haliaeetus vocifer	African Fish-Eagle
Hirundo albigularis	White-throated Swallow
Hirundo cucullata	Greater Striped Swallow
Hirundo fuligula	Rock Martin
Hirundo rustica	Barn Swallow
Indicator minor	Lesser Honeyguide
Laniarius ferrugineus	Southern Boubou
Lanius collaris	Common Fiscal
Macronyx capensis	Cape Longclaw
Megaceryle maximus	Giant Kingfisher
Milvus aegyptius	Yellow-billed Kite
Motacilla capensis	Cape Wagtail
Nectarinia famosa	Malachite Sunbird
Neotis denhami	Denham's Bustard
Numida meleagris	Helmeted Guineafowl
Nycticorax nycticorax	Black-crowned Night-Heron
Oena capensis	Namaqua Dove
Onychognathus morio	Red-winged Starling
Passer domesticus	House Sparrow
Passer melanurus	Cape Sparrow
Phalacrocorax africanus	Reed Cormorant
Phalacrocorax carbo	White-breasted Cormorant
Platalea alba	African Spoonbill
Plectropterus gambensis	Spur-winged Goose
Ploceus capensis	Cape Weaver
Polyboroides typus	African Harrier-Hawk
Porphyrio madagascariensis	African Purple Swamphen
Psalidoprocne holomelaena	Black Saw-wing
Pternistis capensis	Cape Spurfowl
Pycnonotus capensis	Cape Bulbul
Saxicola torquatus	African Stonechat
Scopus umbretta	Hamerkop Hamerkop
Serinus canicollis	Cape Canary

Sigelus silens	Fiscal Flycatcher
Sphenoeacus afer	Cape Grassbird
Spreo bicolor	Pied Starling
Stenostira scita	Fairy Flycatcher
Streptopelia capicola	Cape Turtle-Dove
Streptopelia semitorquata	Red-eyed Dove
Streptopelia senegalensis	Laughing Dove
Struthio camelus	Common Ostrich
Sturnus vulgaris	Common Starling
Sylvietta rufescens	Long-billed Crombec
Tachybaptus ruficollis	Little Grebe
Tadorna cana	South African Shelduck
Telophorus zeylonus	Bokmakierie Bokmakierie
Terpsiphone viridis	African Paradise-Flycatcher
Thalassornis leuconotus	White-backed Duck
Threskiornis aethiopicus	African Sacred Ibis
Tricholaema leucomelas	Acacia Pied Barbet
Turdus olivaceus	Olive Thrush
Turtur tympanistria	Tambourine Dove
Upupa africana	African Hoopoe
Urocolius indicus	Red-faced Mousebird
Vanellus armatus	Blacksmith Lapwing
Vanellus coronatus	Crowned Lapwing
Vidua macroura	Pin-tailed Whydah
Zosterops virens	Cape White-eye