Chapter 2
STUDY AREA

2.1 INTRODUCTION

This study was carried out in Sandveld Nature Reserve (SNR) ($27^0$37'S; $25^0$46'E) situated in the north-western Free State and on two neighbouring farms Josina and Rietvlei. The study area lies between Hoopstad and Bloemhof on the banks of the Bloemhof dam. The area is situated in the eastern variance of the Kalahari Thornveld (Acocks, 1988). SNR covers an area of 15283 ha. It was proclaimed a nature reserve on 9 May 1980. Before its proclamation as nature reserve the area was fragmented into different farms where maize was the main crop cultivated. The Bloemhof dam within the nature reserve covers 25 000 ha when full. Building of the dam, which is situated in the confluence of the Vaal River and the Vet Rivers, commenced in 1965 and was completed in 1970 (Potgieter, 1975). The study took place in four areas, a grassveld area in the nature reserve; a grassveld area on the farm Rietvlei; a bushveld area in the nature reserve and a bushveld area on the farm Josina. The grassveld area lies in the north-east of the nature reserve and covers an area of 4010 ha. The farm Rietvlei borders this grassveld area. It covers an area of 4500 ha of which 3800 ha consists of grazing fenced off into different pastures and 700 ha consist of maize fields. The bushveld area in this study, 4947ha in extent, lies on the south-eastern side of the nature reserve. The farm Josina borders on this bushveld area. This farm covers an area of 538 ha and consists of 147 *Acacia erioloba*-bushveld, 48 ha cleared *A. erioloba*-grassveld, 110 ha maize fields, 50 ha artificial pastures, 26 ha *A. erioloba* and *A. karoo*-grassveld, 70 ha *A. karoo*-grassveld and 89 ha abandoned fields.

The study area is a typical savanna ecosystem, which is characterised by high daytime temperatures, distinct wet and dry seasons of varying length, with downpours alternating with extended periods of drought. This is a system also characterised by the dominance of grass. In most places, however, savannas also support a scattering of trees and certain other woody plants that can withstand the long dry seasons. Although all savanna

ecosystems are by definition similar, functionally each situation is unique. There are differences in physical determinants and these in turn influence the biological interactions that are based on these determinants. Individual specie's properties are unique to each spatial and temporal situation (Teague & Smit, 1992). The problem in South Africa today is that the grazing ecosystems are, in many cases, artificial. As early as 1835 farmers, looking for better grazing for their cattle, settled in the area between the Vaal- and the Vet River (the area between Hoopstad and Bloemhof today) (Potgieter, 1975). In 1880 there were already 77000 cattle, 583 000 Merino sheep, 18 000 Afrikaner sheep and 13 000 horses in this area (Jacobs, 1952 in Viljoen 1979). As a result of this a great deal of pressure has been placed on grazing resources in the area, and this is one of the main reasons for large increases in woody biomass. Teague (1992) states that the arid/eutrophic savannas are characterised by high levels of grazing and browsing herbivory, which results in relatively low plant biomass. According to Opperman (1980) the biotic diversity of both the producers and consumers, as well as the circulation of minerals also declined radically due to farming practices in South Africa. The result of these farming practices is a drastic change in the abiotic environment, which affects microclimatic conditions. This in turn affects the organisms occurring in the ecosystem. Farming practices therefore resulted, to a large extent, in artificial grazing ecosystems in South Africa today. In order to understand the interactions in the study area it is important to look at both the abiotic and biotic components in the system.

2.2. ABIOTIC FACTORS

Topography

The study area lies between 1228 and 1271 m above sea level (Viljoen, 1979). It is a flat plane, which gradually slopes down towards the dam. An approximately 1km long stabilised sand dune occurs in the northern part.

Climate

The climate of an area can be seen as the interaction of different climatic factors. To get an idea of the climate of the study area different climatic aspects will be discussed. Data for the area were obtained from the weather station at Bloemhof. Ten year's data were available for the rainfall and temperature and five year's data for the relative humidity.

Rainfall

The study area is characterised by semi-arid conditions with moisture shortages in both the wet and the dry season and is subject to low rainfall and often long drought periods. The average rainfall in the study area from 1988 to 1997 was 509.4mm. The lowest rainfall during the ten-year period was 230mm in 1994 (Fig. 2.1). In 1992 274.1mm fell (Fig.2.1), also much lower than the 10-year average. The highest rainfall during the ten-year period was 772mm in 1988 and 616.25mm in 1996, which is above the 10-year average (Fig 2.1). In this area, wet years are alternated with dry years (Fig 2.1). According to Opperman (1980), every 2-4 years, 31% of South Africa's rainfall is 20% or more lower than average. Consequently, it appears that drought is a normal phenomenon in the study area.

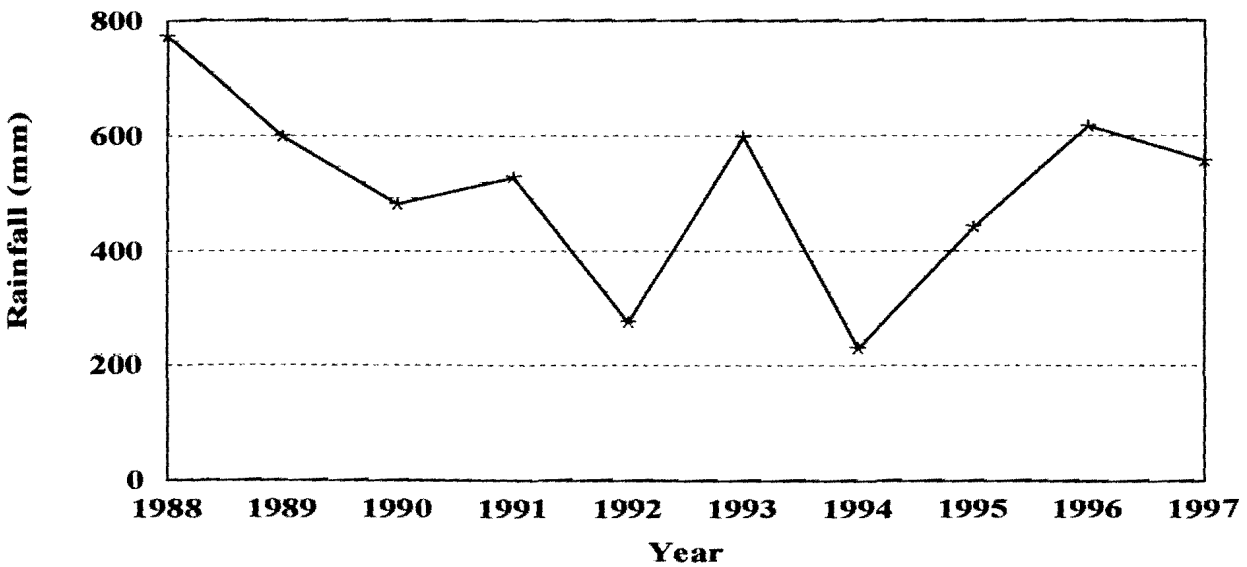

Fig. 2.1: Average yearly rainfall at SNR and neighbouring farms between 1988 and 1997.

The highest rainfall in the study area occurred from January to April. It decreased from May, with May, June, July, August and September as the driest months (Fig 2.2). The highest average monthly rainfall between 1988 and 1997 was 90.2mm during February and the lowest was 3.6mm during June (Fig. 2.2.). Rain in the area usually occurs as isolated showers and thunderstorms.

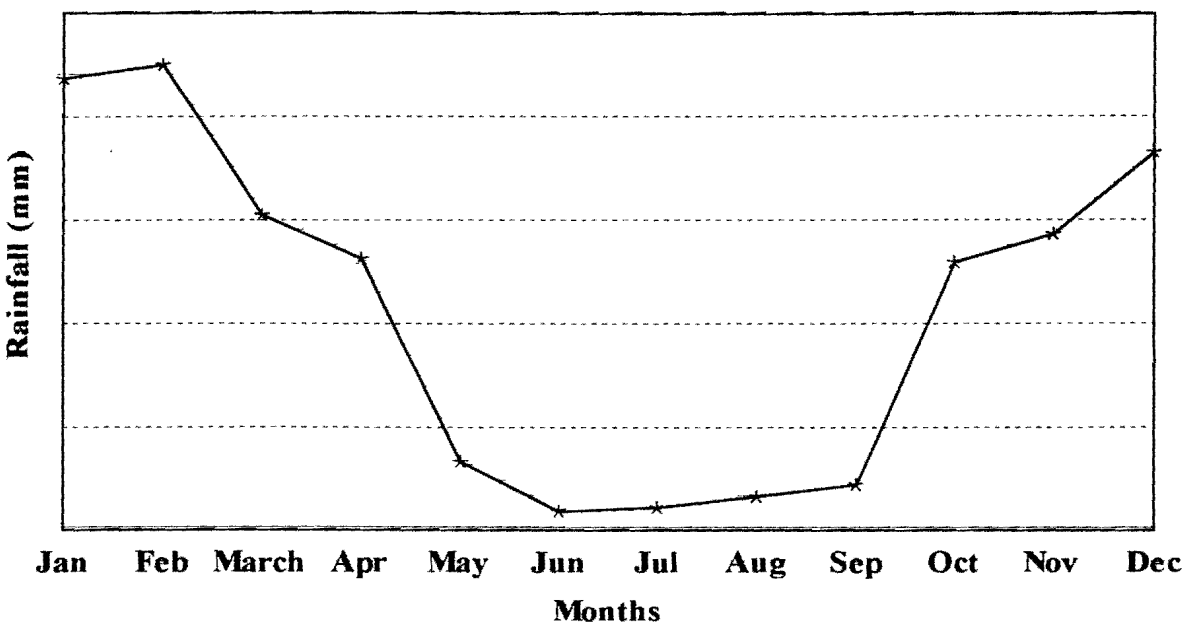

Fig. 2.2: Average monthly rainfall at SNR and neighbouring farms between 1988 and 1997.

Temperature

The study area is characterised by very hot summers and very cold winters. The average maximum temperature in this area, from 1988 to 1997, was 26.8°C. The average minimum temperature during the period was 9.7°C, while the average daily temperature was 18.25°C. The days are usually very hot throughout the year, while the nights are cold. The mean daily shift in temperature was 17.1°C. The highest shift in daily temperatures occurred during the winter months from June to September where the mean

daily temperature shift was 18.1°C, 18.4°C, 18.7 °C and 19°C for June, July, August and September respectively (Fig. 2.3).

The hottest time of the year was between November and February. The average maximum temperatures for these months were 31.7°C, 32.6°C, 33.2°C and 31.3°C for November, December, January and February respectively (Fig. 2.4). The average minimum temperatures for these months were 13.9°C, 15.7°C, 17.6°C and 16.1°C respectively (Fig. 2.4). The highest daily maximum temperature recorded during the ten-year period was 40,4°C on 10 December 1997. The highest average monthly maximum temperature ever recorded in this area was 40°C during November 1904 (Viljoen, 1979).

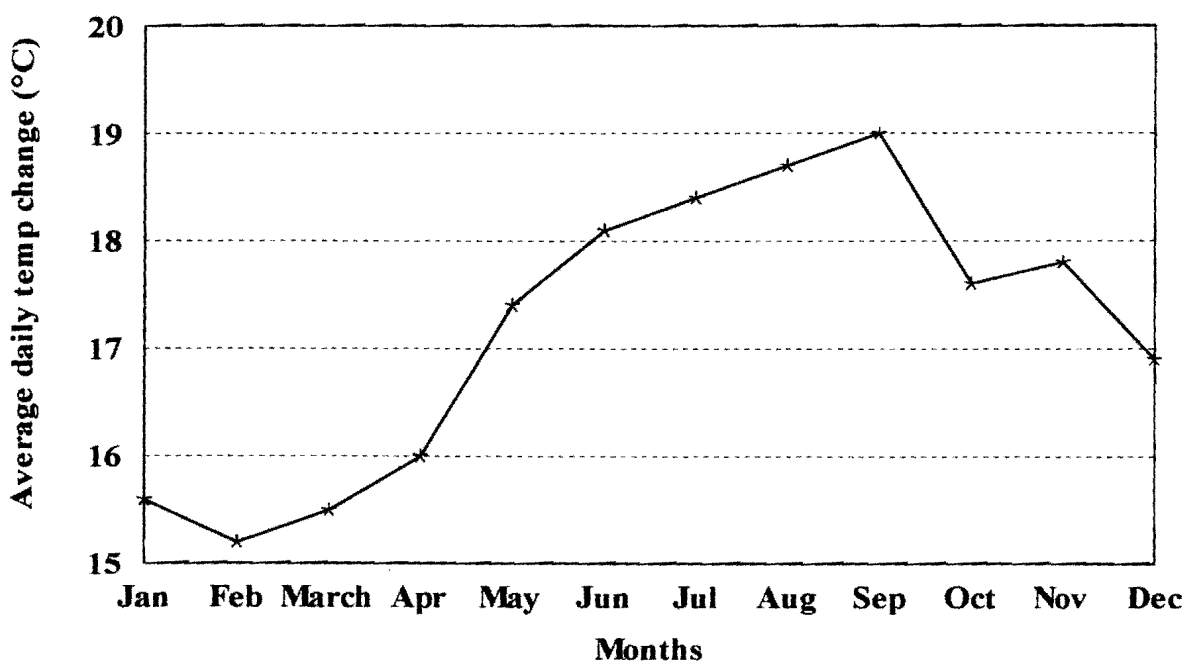

Fig. 2.3: Average daily temperature shift at SNR and neighbouring farms between 1988 and 1997.

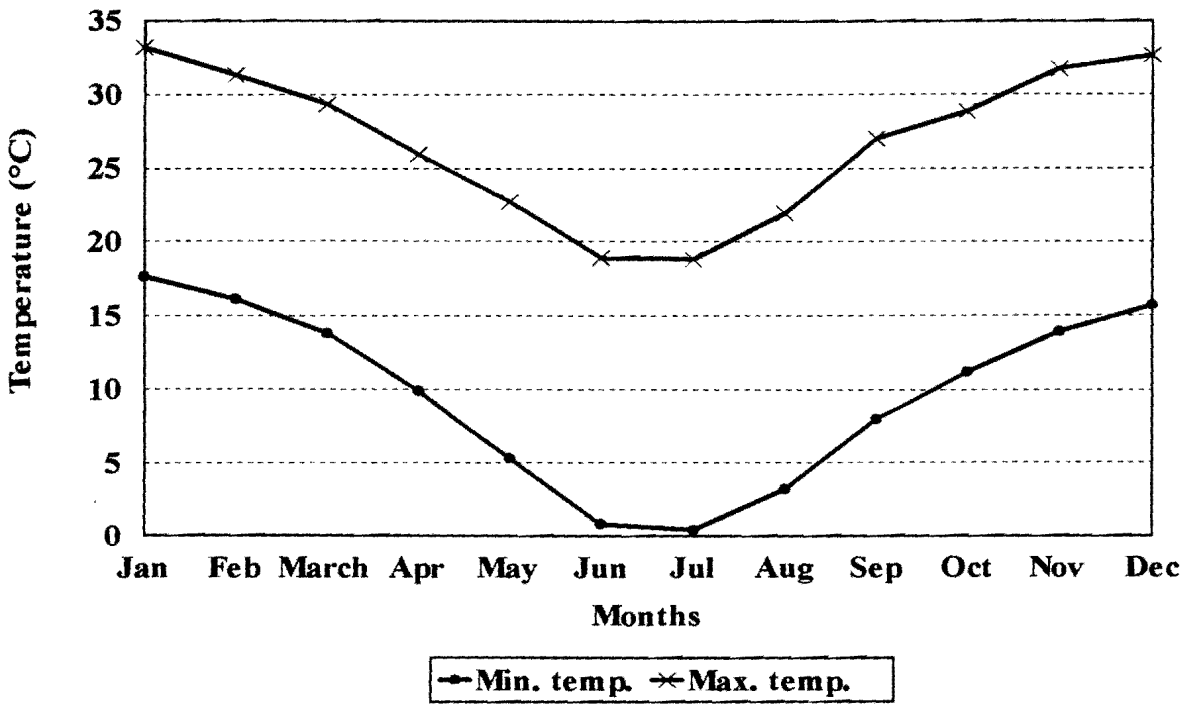

Fig. 2.4: Average monthly minimum and maximum temperature at SNR and neighbouring farms between 1988 and 1997.

The coldest time of the year is during June and July. The average maximum temperatures were 18.9°C and 18.8°C for June and July respectively, while the average minimum temperatures were 0.8°C and 0.4°C (Fig. 2.4.). The lowest daily minimum temperature recorded during the ten-year period was –8°C on 12 July 1994 and 19 July 1995. The lowest average monthly temperature ever recorded at the study area was -11.1°C during June 1920 (Viljoen, 1979).

Relative Humidity (RH)

RH is a percentage-indication of the moisture saturation in the atmosphere, regardless of the temperature. The lowest minimum RH in the study area during a five-year period from 1993 to 1997 was 11% in September 1994, while the highest maximum RH was 98% during March 1997. Average monthly minimum and maximum RH was lowest from August to November, while it was highest from March to May (Fig.2.5). The relatively

low humidity in this area may result in a high evaporation and transpiration rate and is therefore of great ecological importance for the biotic components in this area.

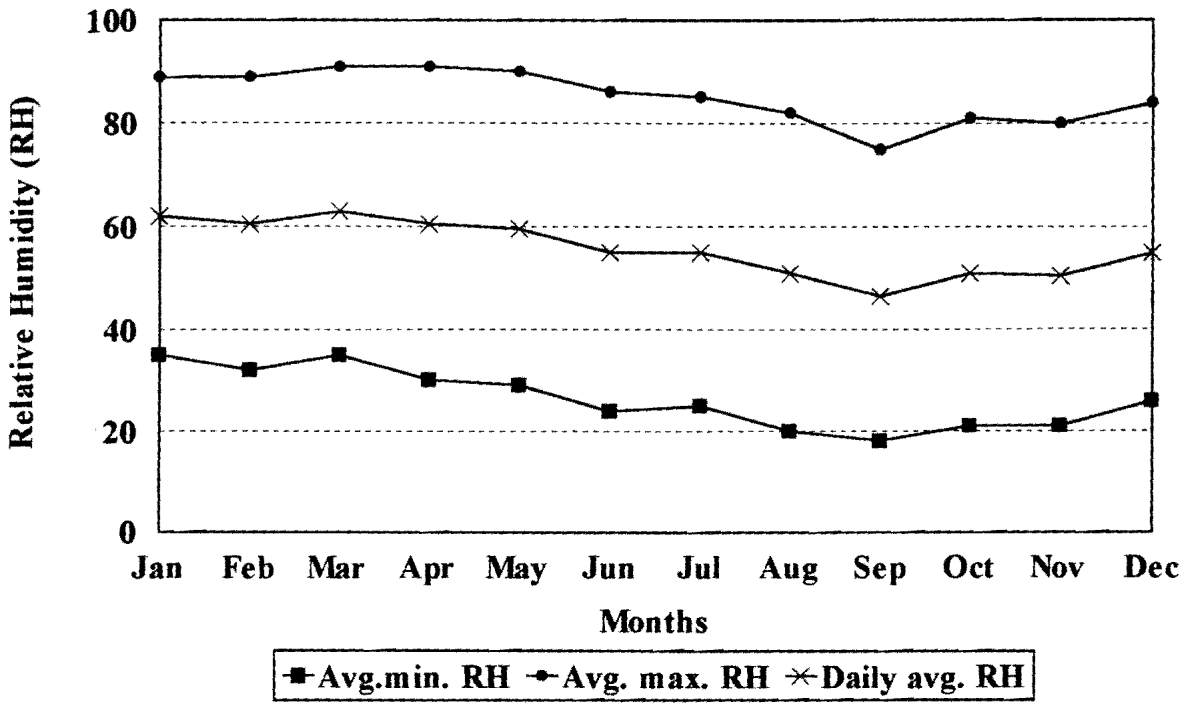

Fig. 2.5: Average monthly minimum, maximum and daily Relative Humidity at SNR and neighbouring farms between 1993 and 1997.

Soil

On the basis of colour, texture, chemical composition, plants growing in the soil and other distinctive characteristics, the soil at Sandveld can be divided into various groups.

The soil in the grassveld area at Sandveld and on the farm Rietvlei consists mainly of yellow/brown sandy soil. It consists of 0.85% silt; 3.9% clay; 21.5% fine sand; 68.1% medium sand and 5.2% coarse sand (Viljoen, 1979). With the exception of yellow sandy soil this is the most barren in the study area (Viljoen, 1979). Yellow sandy soil occurs in the stabilised sand dune. It contains the least nutrients and has the coarsest structure of all the soil types in the study area. It consists of 0.2% clay; 24.2% fine sand; 69.6% medium sand and 4.3% coarse sand (Viljoen, 1979).

The soil in the bushveld area at Sandveld and on the farm Josina consists of a combination of brown sandy soil and organic soil. The brown sandy soil differs in colour from the yellow sandy soil and is also richer in nutrients and has a finer texture. It consists of 0.85% silt; 6.4% clay; 44% fine sand; 43.7% medium sand and 4.2% coarse sand (Viljoen, 1979). The organic soil is characteristic of areas where scatterings of trees occur in the grassveld areas and is confined to areas under trees or bushes. This soil type occurs as a mosaic in the brown sandy soil and has a high nutrient value. It consists of 1.60% silt; 8.0% clay; 31.2% fine sand; 52.5% medium sand and 3.8% coarse sand (Viljoen, 1979).

2.3. BIOTIC FACTORS

Vegetation

According to Fourie and du Toit (1983) low growth potential is usually the first indicator of deterioration of the veld and poor ground cover is usually a symptom of advanced deterioration. The plant species composition shows the relative abundance and interactions of plant species in the cover and gives and idea of where the plant community occurs in succession. The plant species composition for the four different habitats concerned in the study area was determined with a 100 point survey at different sites. Strikes on living basal area were recorded and, in the absence of a strike, nearest plant data was recorded. The ecological classification, successional classification and basal cover were determined from this information. The grass species in the study area can be divided into four groups:

i) Decreasers: species which are typically found in veld in good condition, and which decrease in abundance with under- and over-utilization.

ii) Increaser 2A: species which increase when the veld is moderately overgrazed or selectively moderately grazed.

iii) Increaser 2B: species which increase when veld is heavily overgrazed or selectively heavily grazed.

iv) Increaser 2C: species which increase when the veld is excessively overgrazed.

The grassveld area of SNR used to be cultivated fields. The grass component is relatively uniform in this area. The most abundant grass species occurring in the grassveld area at SNR are *Eragrostis lehmanniana* (11.78%), *Eragrostis trichophora* (7.78%), *Setaria sphacelata* (6.44%) and *Cynodon dactylon* (6.22%) (Table 2.1). The relatively high occurrence of shrubs (39.44%), *Eragrostis lehmanniana* (11.78%) and *E. trichophora* (7.78%), which are sub-climax species, and the low percentage of climax (decreaser) species are indications that the veld in this area is in subclimax (Fig. 2.6). The plant community in this area is dominated by species belonging to Increaser 2B (40.66%; Table 2.1), which increases when veld is heavily overgrazed. Species belonging to the other groups, however, also make up a fairly large percentage of the plant community, indicating that, although the veld is not in a perfect condition, the level of overgrazing is still manageable (Table 2.1).

The most abundant species at Rietvlei are *Cynodon dactylon* (67.67%), *Eragrostis lehmanniana* Nees and *Aristida mollissima* (5.67%) (Table 2.1.). The very high occurrence of *Cynodon dactylon* (67.67%), which is a pioneer species, and the low occurrence of climax and sub-climax species are indications that the veld at Rietvlei is in a pioneer stage (Fig. 2.6). The very high percentage of 2C increaser species and the low percentage of decreaser species are indications that the veld is excessively overgrazed.
In the bushveld area at SNR *Acacia erioloba* is the dominant tree species with *Acacia karoo, Rhus lancea, Rhus pyroides, Grewia flava, Ziziphus mucronata, Diospyros lycioides, Boscia albitrunca* and *Ehretia rigida* also occurring here. The most abundant grass species in the bushveld area at Sandveld are *Eragrostis trichophora* (19.25%), *Eragrostis lehmanniana* (12.5%), *Cynodon dactylon* (10.25%) *Schmidtia pappophoroides* (7.25%) and *Brachiaria nigropedata* (4.75%) (Table 2.1). The high occurrence of shrubs (23.75%), *Eragrostis lehmannian* (12.5%) and *E. trichophora* (19.25%), which are sub-climax species and the low occurrence of climax (decreasers) and pioneer species are indications that the veld is in subclimax (Fig. 2.6). There is not high dominance of either of the three groups Increaser 2A, Increaser 2B or Increaser 2C (Table 2.1), indicating that the degree of overgrazing is manageable.

The most abundant grass species on the farm Josina are *Schmidtia pappophoroides* (14%), *Eragrostis lehmanniana* (17.5%), *Eragrostis trichophora* (30%), *Stipagrostis uniplumis* (4.25%) and *Tragus koelerioides* (3.75%) (Table 2.1). The high occurrence of *Eragrostis lehmanniana* (17.5%) and *Eragrostis trichophora* (30%), and the relatively low occurrence of climax and pioneer species are indications that the veld is in subclimax (Fig. 2.6). The plant community is dominated by species belonging to the group increaser 2A (Table 2.1) indicting the veld is moderately overgrazed.

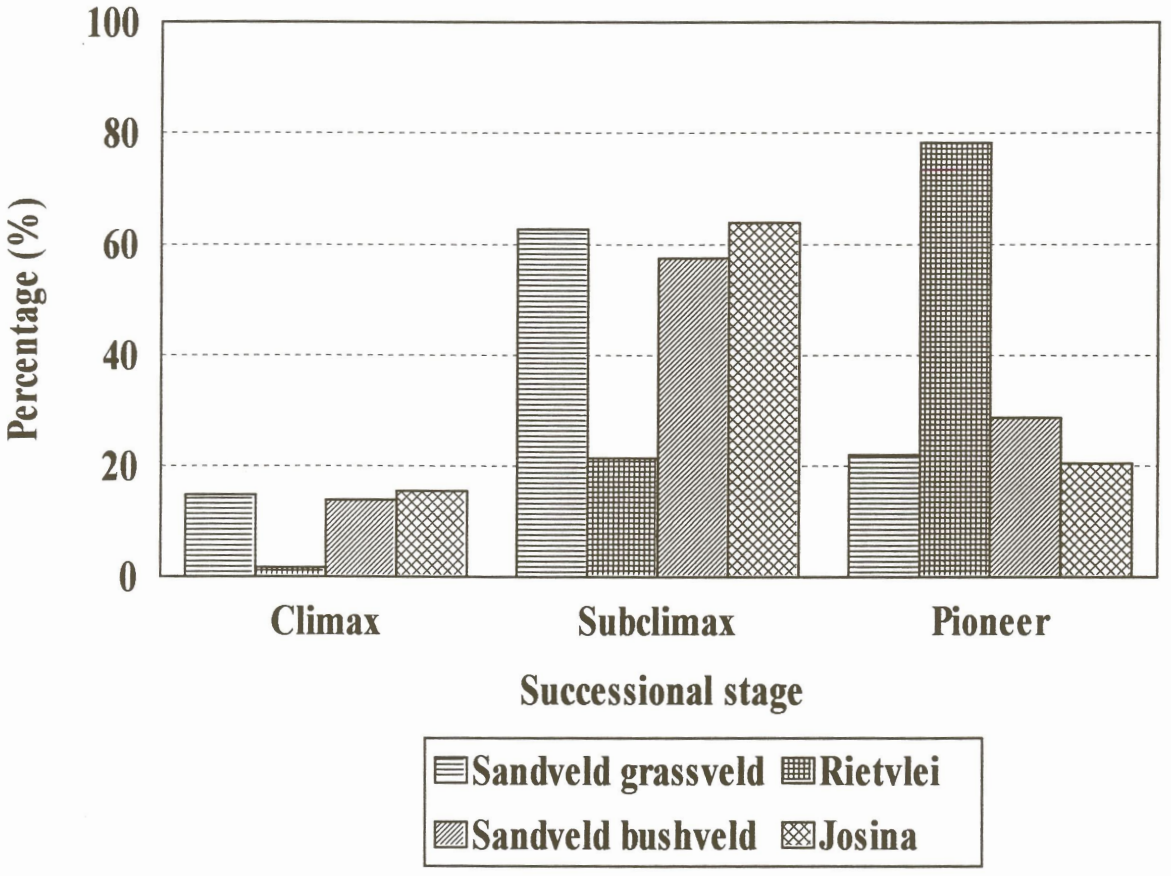

Fig. 2.6: Successional stages of the veld in the four different habitats (Sandveld Grassveld-natural grassveld habitat, Rietvlei-disturbed grassveld habitat, Sandveld Bushveld-natural bushveld habitat, Josina-disturbed bushveld habitat.)

Table 2.1: Percentage species composition, ecological classification, successional classification, basal cover and relative veld condition of the four different habitats (Sandveld Grassveld-natural grassveld habitat in Sandveld Nature Reserve, Rietvlei-disturbed grassveld habitat, Sandveld Bushveld-natural bushveld habitat in Sandveld Nature Reserve, Josina-disturbed bushveld habitat.)

Species	Sandveld Grassveld	Rietvlei (Grassveld)	Sandveld Bushveld	Josina (Bushveld)
Decreaser	%	%	%	%
Antephora pubescens	3.33		0.5	
Brachiaria nigropedata			4.75	1
Digitaria argyrograpta	0.56			
Digitaria eriantha	0.56	0.17		
Eragrostis capensis			0.25	
Panicum coloratum	2.22			
Panicum kalaharense	0.22	0.17		
Panicum stapfianum	0.44	0.17		
Schmidtia pappophoroides	0.33		7.25	14
Setaria sphacelata	6.44	1.17	0.75	
Sporobolus fimbriatus	0.11		0.25	
Themeda triandra	0.56			0.5
Increaser 2a				
Eragrostis lehmanniana	11.78	8.33	12.5	17.5
Eragrostis trichophora	7.78	1.33	19.25	30
Stipagrostis uniplumis	2.56	2.83	0.5	4.25
Increaser 2B				
Chloris virgata			0.25	
Cynodon hirsutus	0.22			
Elionurus muticus	0.11	0.33		
Eragrostis biflora			0.25	
Eragrostis pallens	0.67	0.17		
Eragrostis gummiflua		0.17		
Urochloa panicoides	0.22		1	
Schrubs	8.3	39.44	23.75	12.25
Increaser 2C				
Aristida mollissima	1.44	5.67		
Aristida meridionalis	0.89	0.17		
Aristida congesta.	0.56	1.17	2	0.5
Aristida junciformis		0.17		
Aristida stipitata	0.33	0.5	2.25	1.75
Cynodon dactylon	6.22	67.67	10.25	14
Microchloa caffra	0.11			
Pogonarthria squarrosa	2.11	2.3		0.5
Setaria sp.	0.11			
Tragus koelerioides	0.67	0.17	0.5	3.75
Urelytrum agropyroides	0.11	0.5		
Grass seedlings	9.44		13.75	
Ecological classification				
Decreasers	14.77	1.68	13.75	15.5
Increasers 2a	22.12	12.49	32.25	51.75
Increasers 2B	40.66	8.97	25.25	12.25
Increasers 2C	21.99	78.32	28.75	20.5
Sucessional classification				
Climax	14.77	1.68	13.75	15.5
Subclimax	62.78	21.46	57.5	64
Pioneer	21.99	78.32	28.75	20.5
Basal cover	3.71	1	3.22	2.25
Relative veld condition	64.3	42.8	59.1	55.06

According to Nel (1991) the condition of the veld is primarily related to its ecological status (such as succession stage, species composition and cover density). Van Oudtshoorn (1991) also states that there is a definite correlation between the grazing value of an area and the stage of succession of the veld. Grass in a pioneer stage has a short growth cycle and is dependent on seed-production for survival. Very little energy for leaf production is available, resulting in low leafmass production and low grazing value. Climax- and subclimax-species are perennial and dependent on leaf production for survival. This survival mechanism results in a higher grazing value. Climax- and subclimax communities also prevent soil erosion and ensure the best utilization of soil moisture. Climax vegetation is therefore, from a conservation point of view, the ideal condition (Nel, 1991). The veld in the grassveld and bushveld area at Sandveld and at Josina is in a subclimax stage, and therefore in a satisfactory condition, while the veld at Rietvlei is in a pioneer stage and therefore in a less satisfactory condition (Fig. 2.6). Pioneer species should not make out more than 3% of the total botanical composition (H. du Toit, unpublished) and at Rietvlei the pioneer species make up 78.32% of the botanical composition (Fig. 2.6.).

According to Fourie et. al. (1984 in Snyman & Fouche, 1993) basal cover in arid areas is a better indicator of veld condition than plant composition. A percentage value is an indication of the percentage of ground covered by living plants. A basal cover of 10%-14% is excellent, 8%-9% good, 6%-7% relatively good and < 6% bad (H. du Toit, unpublished). Veld in good condition responds better to good rain than veld in bad condition and this results in low plant production in veld in a poor condition (Snyman & Fouche, 1993). Water flows away and pseudo-drought occurs despite good rain. The climax grass is replaced by hardier grass species, which are better able to survive drought (Snyman & Fouche, 1993). The farm Rietvlei has the lowest basal cover of only 1%. The farm Josina has a higher basal cover of 2.25%, while the highest basal cover can be found in the grassveld area (3.71%) and the bushveld area (3.22%) at Sandveld (Table 2.1). The basal cover here is an indication that the veld in all these areas is vulnerable to over-exploitation.

Relative veld condition describes the state of health of a specific part of the veld. Fourie & du Toit (1983) found that veld is in an optimal condition when 60% to 80% consists of group A species, 10% to 30% group B species, 10% to 20% group C species and 1% to 5% group D species. A reference point as suggested by Fourie & du Toit was used to measure the veld condition as follows: a plant composition of 70%, 25%, 3% and 2% for groups A, B, C and D respectively. The grassveld area at SNR has the best veld condition of 64%, followed by the bushveld area at SNR (59.1%) and Josina (55.06%) (Table 2.1). The farm Rietvlei has the lowest percentage veld condition of all four habitats (42.8%) (Table 2.1).

It can be concluded from the data in Table 2.1 and Fig. 2.6. that the veld in the grassveld area and bushveld area in SNR is in a better condition than the veld on the neighbouring farms. The veld at Josina is also in a better condition than the veld at Rietvlei.

Large Herbivores

Large herds of antelope occurred in the Hoopstad district before the settlement of farmers. According to Harris (1841 in Viljoen 1979) large herds of *Antidorcas marsupialis* (springbuck) and *Damliscus dorcal phillipsi* (blesbuck) occurred abundantly in this area. Although blesbuck does not occur in the area today springbuck were reintroduced after the proclamation of Sandveld as a nature reserve. Various other species of large antelope were also introduced and today a large variety of antelope, which settled successfully, occur here.

Large herbivores occurring in the grassveld area of SNR are *Antidorcas marsupialis* (springbuck), *Aepyceros melampus* (impala), *Alcelaphus buselaphus* (red hartebeest), *Oryx gazella* (gemsbuck), *Taurotragus oryx* (eland), *Connochaetes gnou* (black wildebeest) and *Equus burchelli* (zebra). Game counts were done from October 1997 to May 1998 and the average abundance per month for each species was taken as an indication of abundance of these species. Black wildebeest occurred most abundantly

(258), followed by gemsbuck (159), zebra (147) and red hartebeest (128) (Table 2.2.). The largest concentration of large herbivores in this area occurred during November. Their numbers in this area decreased from December to February and increased again during March (Table 2.2). This is probably due to the fact that most of the large herbivores favour the trees on other parts of the reserve during the hotter time of the year.

A greater diversity of large herbivores occurs in the bushveld area of Sandveld than in the grassveld area. Large herbivores occurring here are *Antidorcas marsupialis (*springbuck), *Aepyceros melampus* (impala), *Alcelaphus buselaphus* (red hartebeest), *Oryx gazella (*gemsbuck), *Hippotragus equinus (*roan), *Hippotragus niger* (sable), *Giraffa camelopardalis* (giraffe), *Tragelaphus strepsiceros* (kudu), *Taurotragus oryx* (eland), *Connochaetes taurinus* (blue wildebeest), *Syncerus caffer* (buffalo), *Equus burchelli* (zebra) and *Ceratotherium simum* (white rhinoceros). Game counts were done from August 1997 to May 1998 and the average abundance per month for each species was taken as an indication of abundance of these species. Springbuck occurred most abundantly in this area (836), followed by gemsbuck (346), blue wildebeest (262) and red hartebeest (216) (Table 2.3).

The farm Rietvlei is fenced off into pastures. The only large herbivores occurring on this farm are cattle. Each pasture of 5 ha is grazed by ±20 head of cattle per year.

The farm Josina is in the process of being turned into a game farm. The result is a combination of wild herbivores and domesticated herbivores occurring together in the same area. Currently 40 sheep, 80 head of cattle, 60 Springbuck and 40 Eland occur on the farm. The farm is not fenced off into different camps and the animals are free to move across the whole area.

Table 2.2: Distribution of large herbivores in the grassveld area of SNR based on game counts from October 1997 to May 1998.

Month	Ruminants						Non-ruminants	
	Antidorcas marsupialis (Springbuck)	*Aepyceros melampus* (Impala)	*Alcelaphus buselaphus* (Red Hartebeest)	*Oryx gazella* (Gemsbuck)	*Taurotragus oryx* (Eland)	*Connochaetes gnou* (Black wildebeest)	*Equus burchelli* (Zebra)	**Total**
1997								
October		8	7	29	9	29	21	**103**
November			37	35	32	77	23	**204**
December	18		31			7	61	**117**
1998								
February			15	12	10	37		**74**
March	7	12	22	47	9	44		**141**
May			16	36		64	42	**158**
Total	**25**	**20**	**128**	**159**	**60**	**258**	**147**	

Table 2.3: Distribution of large herbivores in the bushveld area of SNR based on game counts from August 1997 to May 1998.

Month	Ruminants									Non-ruminants				
	Antidorcas marsupialis (Springbuck)	*Aepyceros melampus* (Impala)	*Alcelaphus buselaphus* (Red Hartebeest)	*Oryx gazella* (Gemsbuck)	*Hippotragus equinus* (Roan)	*Hippotragus niger* (Sable)	*Giraffa camelopardalis* (Giraffe)	*Tragelaphus strepsiceros* (Kudu)	*Taurotragus oryx* (Eland)	*Connochaetes taurinus* (Blue wildebeest)	*Syncerus caffer* (Buffalo)	*Equus burchelli* (Zebra)	*Ceratotherium simum* (White rhinocerous)	Tot.
1997														
Aug	40		2	52		15				36		7	3	**155**
Sept	85	7	18	35		6		6	5	16	2	14	4	**198**
Oct	33	2	9	23		5	4	2	1	15	2	3	2	**101**
Nov	106		23	38	2	5	11	2	3	19	1	3	1	**214**
Dec	170	4	47	21	1		3			45				**291**
1998														
Febr	47	2	13	21	2	9	2			23		2	8	**129**
March	135	16	36	38	1	5	7	2		34		2	2	**278**
Apr	130	18	33	52	1	6	3	1	2	39		13	1	**299**
May	90	15	35	66		8	2	4	2	35		6	2	**265**
Total	**836**	**64**	**216**	**346**	**7**	**59**	**32**	**17**	**13**	**262**	**5**	**50**	**23**	

Dung beetles

All the above mentioned factors will probably influence the distribution of dung beetle assemblages in the area significantly. There is a diverse dung beetle fauna at SNR and the neighbouring farms. Eighty-three species belonging to 26 genera were collected in the area from July 1996 to June 1998 (Table 2.4). All the functional groups proposed by Doube (1990) (F.G. I – F.G. VII) are represented here and sizes range from 0.0006 ± 0.0002g dry mass to 1.49 ± 0.27g dry mass (Table 2.4).

Table 2.4: Dung beetle species occurring at Sandveld Nature Reserve and neighbouring farms

Abbreviation	Name	Functional Group	Mean Dry Mass (g) ± SD (n=20)
at	*Allogymnopleurus thalassinus*	II	0.061 ± 0.51
ap	*Aphodius (Aganocrossus) periculosus*	VII	0.002 ± 0.0005
av	*Aphodius (Aganocrossus) vestitus*	VII	0.002 ± 0.0007
al	*Aphodius (Bodilus) laterosetosus*	VII	0.002 ± 0.003
apl	*Aphodius (Labarus) pseudolividus*	VII	0.002 ± 0.0005
ad	*Aphodius (Mesontoplatys) dorsalis*	VII	0.0007 ± 0.012
an	*Aphodius (Nialaphodius) nigrita*	VII	0.002 ± 0.004
adu	*Aphodius (Pharaphodius) dubiosus*	VII	0.003 ± 0.0005
ai	*Aphodius (Pharaphodius) impurus*	VII	0.003 ± 0.0007
as	*Aphodius (Plagiogonus) separatus*	VII	0.001 ± 0.0005
ats	*Aphodius (Pleuraphodius) teter sensu lato*	VII	0.0006 ± 0.0002
ac	*Aphodius (Trichaphodioides) calcaratus*	VII	0.002 ± 0.0004
acs	*Aphodius consimilis*	VII	0.002 ± 0.0007
cf	*Caccobius ferruginus*	VI	0.004 ± 0.003
cs	*Caccobius seminulum*	VI	0.001 ± 0.003
cc	*Catharsius calaharicus*	III	0.588 ± 0.02
cm	*Catharsius melancholicus*	III	0.59 ± 0.03
ct	*Catharsius tricornutus*	III	0.686 ± 0.001
ch	*Chironitis sp*	IV	0.072 ± 0.001
cts	*Colobopterus (Teuchestes) sorex*	VII	0.031 ± 0.0002
ccs	*Copris cassius*	III	0.069 ± 0.002
ce	*Copris elphenor*	III	0.52 ± 0.0003
ci	*Copris inhalatus*	III	0.018 ± 0.04
de	*Depanocanthus (Pseudoxyomus) eximius*	VII	0.002 ± 0.0005
dr	*Drepanocanthus (Pseudoxyomus) rubescens*	VII	0.001 ± 0.0003
dp	*Drepanocerus putrizii*	V	0.004 ± 0.0005
dc	*Drepanopodus costatus*	I	0.132 ± 0.003
eg	*Epirinus gratus*	V	0.009 ± 0.001
ea	*Euoniticellus africanus*	IV	0.04 ± 0.002
ei	*Euoniticellus intermedius*	IV	0.029 ± 0.007
ga	*Gymnopleurus aenescens*	II	0.023 ± 0.01
g4	*Gymnopleurus sp. 4*	II	0.025 ± 0.03
ha	*Heliocopris atropos*	III	0.61 ± 0.06
hya	*Hyalonthophagus alcyon*	IV	0.021 ± 0.04
lm	*Liatongus millitaris*	IV	0.02 ± 0.006

Table 2.4 Continued: Dung beetle species occurring at Sandveld Nature Reserve and neighbouring farms

Abbreviation	Name	Functional Group	Mean Dry Mass (g) ± SD (n=20)
me	*Metacatharsius exiguus*	IV	0.07 ± 0.05
ml	*Metacatharsius laticollis*	IV	0.08 ± 0.02
m3	*Metacatharsius sp. 3*	V	0.004 ± 0.0005
nr	*Neosisyphus ruber*	II	0.019 ± 0.002
op	*Oniticellus planatus*	VII	0.029 ± 0.03
oax	*Onitis alexis*	IV	0.46 ± 0.004
oay	*Onitis aygulus*	IV	0.51 ± 0.01
ocf	*Onitis caffer*	IV	0.45 ± 0.02
ocu	*Onitis confusus*	IV	0.49 ± 0.009
oun	*Onitis uncinatus*	IV	0.43 ± 0.0004
oae	*Onthophagus aeruginosus*	IV	0.01 ± 0.002
ocb	*Onthophagus carbonarius*	IV	0.022 ± 0.004
oeb	*Onthophagus ebenus*	IV	0.023 ± 0.003
ofi	*Onthophagus fimetarius*	IV	0.01 ± 0.0009
of	*Onthophagus flavimargo*	IV	0.009 ± 0.06
og	*Onthophagus gazella*	IV	0.027 ± 0.002
ol	*Onthophagus leucopygus*	IV	0.009 ± 0.03
oob	*Onthophagus obtusicornis*	IV	0.018 ± 0.004
opi	*Onthophagus pilosus*	IV	0.011 ± 0.006
opu	*Onthophagus pugionatus*	IV	0.013 ± 0.09
oq	*Onthophagus quadraliceps*	IV	0.014 ± 0.005
osu	*Onthophagus sugillatus*	V	0.003 ± 0.0008
ova	*Onthophagus variegatus*	V	0.003 ± 0.0006
ovi	*Onthophagus vinctus*	V	0.006 ± 0.0004
o1	*Onthophagus sp. 1*	V	0.005 ± 0.001
o2	*Onthophagus sp. 2*	V	0.0018 ± 0.0009
o4	*Onthophagus sp. 4*	V	0.002 ± 0.0005
o16	*Onthophagus sp. 16*	V	0.006 ± 0.0004
o18	*Onthophagus sp. 18*	V	0.005 ± 0.001
ox	*Onthophagus xanthopterus*	IV	0.01 ± 0.009
pf	*Pachylomerus femoralis*	I	1.49 ± 0.27
po	*Pachylomerus opaca*	I	0.635 ± 0.24
p4	*Pedaria sp. 4*	VI	0.006 ± 0.026
pfl	*Phalops flavocinctus*	IV	0.034 ± 0.009
pw	*Phalops wittei*	IV	0.035 ± 0.014
ra	*Rhysemus africanus*	VII	0.0007 ± 0.003
sa	*Scarabaeus ambiguus*	II	0.207 ± 0.026
san	*Scarabaeus anderseni*	II	0.0289 ± 0.23
sb	*Scarabaeus bohemani*	II	0.066 ± 0.09
sf	*Scarabaeus flavicornis*	II	0.158 ± 0.31
sg	*Scarabaeus goryi*	I	1.351 ± 0.19
si	*Scarabaeus inoportunus*	II	0.158 ± 0.002
s1	*Scarabaeus sp. 1*	II	0.066 ± 0.01
sm	*Sisyphus macroruber*	II	0.0188 ± 0.001

Voucher specimens of all material studied are stored in the Department of Zoology and Entomology, U.F.S., Bloemfontein, South Africa.