

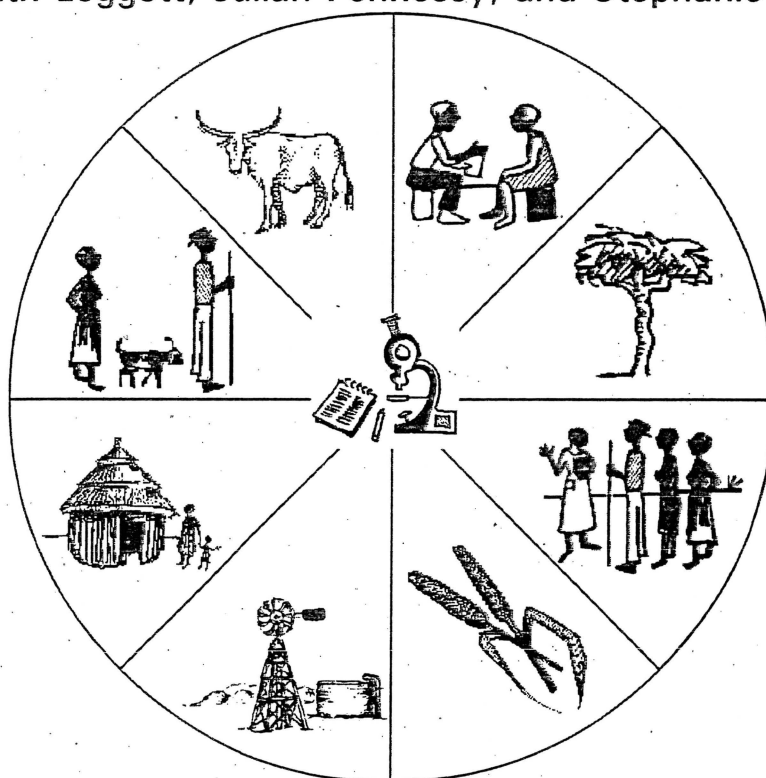


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HOANIB RIVER CATCHMENT STUDY,
NORTHWESTERN NAMIBIA
Fauna

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GENERAL INTRODUCTION

This paper is a result of the research work carried out during the Hoanib River Catchment Study (HRCS) which began in 1998. The HRCS focused on appropriate basic socio-economic, biophysical and policy research on environmental issues important for sustainable use and development of natural resources in the Hoanib River catchment. The investigation examined present methods of lands and associated living conditions and highlighted potential alternatives to existing demands and expectations. Potential conflicts in the area revolve around the dynamics of different discourses and include: escalating, uncontrolled tourism; increasing aspirations and expectations of local residents often based upon popular misinformation; interactions between and among Non Government Organisations (NGOs), Government Ministries, and local people of different language groups; limited water availability and a relatively fragile environment.

This study has been a collaborative effort between relevant Government Ministries and Departments as well as local NGOs. The communities of the Hoanib River catchment are an integral part of the project, as a collaborative process has been used to identify problems, collect data and disseminate results.

As a result of the HRCS, four occasional papers have been published by the Desert Research Foundation (DRFN). These papers cover the general topics of soil, water, fauna, and vegetation in the Hoanib river catchment, and are available for purchase through the DRFN library.

SECTION I

**A PRELIMINARY STUDY OF THE ELEPHANTS
OF THE HOANIB RIVER CATCHMENT,
NORTHWESTERN NAMIBIA**

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ABSTRACT

The elephants of the Hoanib River catchment represent a small but economically and socially significant resource in terms of their potential to attract tourism. Despite this, the elephants cause problems to communities in northwestern Namibia. Two previous studies have examined the elephants in the catchment area, although only one of these was a comprehensive study. This study was conducted during a period of high stress for the elephants. At the time of that study, Namibia was suffering from a drought event that resulted in a high mortality rate amongst domestic stock and wildlife. The stress on the elephants was further compounded by an independence war in the northwest that facilitated a period of intensive poaching activity. One other study had been undertaken at the end of the war, but suffered from satellite collar failures and an in-depth analysis of the elephants was not possible.

For the purposes of this study, the catchment area was geographically divided into two sections by the Khovarib Schlucht and associated north/south mountain range. This range appeared to be a natural division for elephant movement, with little observed movement and interaction between elephants to the east of the Schlucht and those to the west.

The average group size of elephant herds in the eastern section of the catchment was found to have decreased from an observed height of 20in in 1981 to an average size of 3.82in in 2000. While the average group size of elephants in the western section of the catchment decreased from a high of 25in in 1983 to 2.26in in 2000. The group size also appeared to be seasonal with higher group sizes being observed in the cold dry and wet season in the eastern catchment and during the wet and hot dry season in the western catchment.

The age and sex ratios of elephants also appeared to vary from eastern to western sections of the catchment. In the eastern catchment there was a higher ratio of bulls to cows than in the west, which is probably related to the level of human disturbance in each of the areas. The calf to adult female ratio was approximately the same in both sections of the catchment, indicating that both populations are breeding at approximately the same rate.

The group organisation between elephant herds and individuals was investigated in the western section of the catchment only. Associations between different breeding herds was

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shown to be loose affiliations without the strong social bonds reported from other areas of Africa. Adult male group associations were shown to be transient, of small size and irregular.

Historically, adult male associations were thought to be strong, with the bulls spending a larger percentage of their time in group sizes greater than two. However, this appeared only to be the case in the eastern section of the catchment, where the adult males were found in groups throughout the year. In the western section adult males were never observed in groups larger than two and were mostly observed as single animals.

Mortalities of elephants in the catchment were also investigated, with six mortalities reported during the study period. Of these only four appeared to be of natural causes with the other two animals shot by the Ministry of Environment and Tourism (MET) officers as 'problem animals'.

KEY RESEARCH QUESTIONS

Due to increasing economic and social importance of elephants in the Hoanib River catchment to the local communities and conservancies (emerging and established), the research focused on the following questions:

- (1) Elephant/human interaction
 - (i) How many elephants are there and which section of the catchment supports the most elephants?
 - (ii) What effect does human population and activities have on elephant behaviour?
- (2) Elephant group sizes
 - (i) Are the group sizes of elephants seasonally and spatially dependent?
 - (ii) How and why have group sizes changed over time?
- (3) Social interactions and age/sex structure of herds
 - (i) Are there social interactions between herds and individuals?
 - (ii) What is the current age and sex ratios in the elephant populations?
- (4) Elephant mortality
 - (i) What was the mortality rate of elephants and what caused their death?

BACKGROUND

HISTORICAL BACKGROUND

Historically there were probably between 2 500 and 3 500 elephants in northwestern Namibia. This population was hunted extensively by Boer hunters in the later part of the 19th Century without ever substantially decreasing their numbers (Viljoen, 1987). By the 1960s, however, the number of elephants in the northwest was thought to have declined to between 600-800 (Owen-Smith, 1970). This number was further reduced by war and drought to approximately 357 individuals by 1983 (Viljoen, 1987). It is thought that elephant numbers have recovered since this time, however not to 1960s levels. Table 1 is a historical summary of elephant numbers in the Kunene region.

Table 1: Historical elephant numbers in the Kunene Region

Researcher and Year	Estimated Elephant Numbers	Area
Historical (Pre 1900)	2500-3500	Kunene
Owen-Smith (1970)	600-800	Northern Kunene (Koakoland)
Joubert (1972)	211	Northern Kunene (Kaokoland)
De Villiers (1975)	279	Northern Kunene (Kaokoland)
Visagie (1977)	82	Southern Kunene (Damaraland)
Le Roux (1978)	135	Southern Kunene (Damaraland)
Viljoen (1987)	357	Kunene (Damaraland and Kaokoland)
Carter (1990)	253	Kunene (Damaraland and Kaokoland)
Loutit and Douglas-Hamilton (1992)	366	Kunene
Loutit (1993)	359	Kunene
Loutit (1995)	415	Kunene
MET (1998)	579	Kunene

REVIEW OF PREVIOUS RESEARCH

The first substantial research to be conducted on the elephants of the northwest was by P.J. (Slang) Viljoen as part of a PhD study between 1980 and 1983. Numerous papers resulted from this work (Viljoen, 1987, 1988, 1989a, 1989b; Viljoen and Bothma, 1990) covering various aspects of the ecology of the Kunene elephants. Some of the main conclusions from this work were:

Status and distribution

Viljoen estimated the population of the elephants in the northwest was 357 individuals in 1987. These elephants appeared to be split into three distinct populations with no apparent contact between the eastern and western populations detected. Possible genetic exchange could have occurred between these populations via the transitional population. However, during his study, Viljoen observed that this latter population only made infrequent contact with both the eastern and western groups.

The eastern elephant population

This population inhabits the eastern regions of the Kaokoveld bordered by Ombombo in the north, the Huab River in the south and in the west by the Joubert Mountain Range extending down to the Grootberg Mountain range. Two hundred seven individual elephants were counted in this region with a possible maximum of 250, depending on the season (Viljoen, 1987). There was a marked seasonal fluctuation in their population density as they migrated freely to and from Etosha National Park, the former Ovamboland (4 "O" regions) and periodically into the Outjo district. Movement patterns were generally northwest/southeast orientated.

The calving percentage, calculated as the percentage of calves less than one year old in the whole population, was 1.9 in 1983.

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The western elephant population

This group of elephants inhabits an area bordered in the north by the Kunene River, in the south by the Huab River, in the west by the Atlantic ocean and in the east by a line that can be roughly drawn from the Marienfluss in the north to De Riet on the Huab River. This line also roughly corresponds with the 100mm isohyet, although it extends to the 150mm isohyet in the south. According to Viljoen (1987), the 1980 population consisted of 86 individuals but by 1983 the population had decreased to only 70 individuals due to illegal hunting and disturbance. This affected the calving percentage during the period 1980-83, with an observed percentage of 1.38 being recorded, although no calf survived during this period. However, by 1984 the calving percentage had risen to 2.7.

The transitional elephant population

This population inhabits the Grootberg Mountain range area, bordered by the Omumborombonga-Khoraxa-Ams waterholes in the north, the farms Palmwag, Juriesdraai, Spaarwater and Bergsig in the west and the Huab River up to Tweelingskop and Nantis in the east. Viljoen (1987) estimated the total transitional population of elephants was 80. Their calving percentage was 1.3 at the end of 1983. Viljoen (1987) defined the transitional population of elephants as those that were on both sides of the 150mm isohyet. During Viljoen's study, the transitional elephants made contact with both the western and eastern populations on an infrequent basis. During the rainy season the transitional population moved northeast to the vicinity of Omumborombonga where they made contact with members of the eastern population. During the dry months they moved southwest where they infrequently made contact with herds of the western population. The extent of their natural movements was unclear as a veterinary fence, which was erected in 1976, cut through the middle of their home ranges and disrupted their natural migration routes.

Home ranges and daily movements

Viljoen (1989a) calculated the home ranges of the western elephants as between 1 763-2 944km². The majority of the author's observations occurred within 40km of a water source. In particular, concentrations of elephants could be found in the Hoanib floodplain after the

seasonal flooding of the river. Bulls moved during the period November to February, while family movements occurred from January to May. The author established the drinking intervals as 48-96 hrs during the hot dry season and 19-36 hrs during the wet season. In addition, Viljoen (1989a) observed that 92% of movements were within the home ranges of the elephants and to the west of the 150mm isohyet. He observed no mass migration of elephants but rather group movements within a large home range. The ability to predict rainfall/floods and respond with long range movement is a feature of these groups of elephants (Viljoen, 1989a).

Viljoen and Bothma (1990) reported that as the temporary water holes dried up with the onset of the dry season, vegetation around the permanent water holes was consumed first and the elephants moved further afield in search for food. Elephants usually returned to the same water hole to drink, however the relative shifts in locality were small. During the wet season, elephants roamed between temporary water holes over a larger area, resulting in increased daily movements.

Habitat selection and food preference

Viljoen (1989b) defined the 'best habitat' for elephants as the areas where elephants spent the majority of their time. That is, the habitat in which elephants were observed most frequently, or occurred in the highest density, or showed the highest preference in relation to the elephants' overall distribution and the sizes of habitats.

He further defined seven different habitat types as the most common in the northwestern region and these were (in order of preference): floodplain; river courses; sandy plains; rocky plains; gravel plains; mountains and sand dunes.

Highest preferences were observed for river courses and floodplains. Flood plains were occupied predominately during the wet season and with the onset of the dry season the elephants moved into the dry river-course habitats.

The vegetation preferred by the elephants of this area was all woody species (Viljoen, 1989b), with the preference foods being *Cordia sinensis*, *Pachypodium lealii* and *Combretum watii* (though these species did not make up the bulk of the elephant's food). The bulk food species were *Colophospermum mopane*, *Tamarix usneoides* and *Combretum imberbe*.

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ADDITIONAL RESEARCH

Since Viljoen's study, only one additional detailed study has been reported on the elephants in the Kunene region. Lindeque and Lindeque (1991) satellite collared female elephants in northwestern Namibia and tracked their wet season movements. In this study, the authors collared a young adult female in the Hoarusib River (Kaokoland). This elephant was an easily identifiable individual (one tusk pointing downwards) and had not been recorded anywhere prior to 1986.

A satellite collar was also attached to another female in the lower Hoanib River (80km south-east of the Hoarusib river), however this transmitter failed (Lindeque and Lindeque, 1991). Ground observations indicated that the herds merged for much of the study period and moved regularly between the Hoarusib and Hoanib Rivers. There was also evidence from the study that a group of western elephants moved further east than had been recorded in the previous ten years. This was previously a well-used route through the escarpment, as shown by two sites with rocks polished by elephant rubbing and an elephant path visible until at least 1977. This locality is potentially a point of overlap or contact between the eastern, transitional and western populations (Lindeque and Lindeque, 1991). This possibility of overlap casts doubt on the isolation and integrity of previously described populations in the area.

Lindeque and Lindeque (1991) proposed that the present distribution and status of elephants in the Kaokoland reflect a skeletal elephant social organisation. Further, these groups would consist of clans, bond groups and family herds as proposed by Moss and Poole (1983), with substantial reduction in the number of individuals normally constituting each social grouping.

INTRODUCTION

Hoanib River Catchment Study (HRCS) Area

The Hoanib River catchment is one of twelve major ephemeral river catchments that occupy the semi-arid areas of north-western Namibia. All twelve rivers flow into the Atlantic Ocean or end in the Namib Sand Sea. The Hoanib originates in the western edge of the Etosha National Park, flows through commercial and communal farming areas and, near its mouth, traverses the protected Skeleton Coast Park. The Hoanib River catchment occupies an area of 17 200 km², 3% of which lies in private farm lands, 91% in communal farm lands, and 6% is protected in the Etosha National Park and Skeleton Coast Park (Jacobson *et al.*, 1995; Leggett, 1998).

The Hoanib River constitutes the boundary between the former Damaraland and Kaokoland. Since Independence (1990), these two areas have been incorporated into the Kunene and Erongo Regions (see Fig. 1). The Hoanib River catchment can be divided into three broad geographic (and vegetation) sections. The eastern section (east of the Khowarib Schlucht) is relatively densely vegetated with mopane woodland being dominant. The middle section of the Hoanib River (from the Khowarib Schlucht to the Skeleton Coast Park's eastern boundary) is sparsely vegetated. In the western section of the river (from the Skeleton Coast Park boundary to the coast), virtually no vegetation exists outside of the river course. A broad flood plain (some 70km²), which is in front of the coastal dunes, offers substantial grazing for wildlife after flood events during the wet season (Jacobson *et al.*, 1995; Leggett, 1998).

The Hoanib River forms a "linear oasis" where the wetlands in the river provide the most important biological and socio-economic areas in the catchment. This area provides surface water for both domestic stock and wildlife, and serves as a readily available source of water for communities living in the area. Increasingly, water from this source is being used in garden and irrigation projects, as well as for the expanding tourism industry. The biophysical nature of wetlands and other water sources vary over time and is dependent on rainfall and water extraction. Elephants use the wetlands and borehole water extensively. They require an average of at least 160L of water a day (Sikes, 1971) although they can go up to three days without drinking and travel large distances in the search of fresh water (Viljoen, 1988). The sheer volume of water they require places added pressure on wetlands and waterholes that are already used extensively by people and their domestic stock. This has resulted in conflicts

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arising between elephants, domestic stock and people at these watering points. As has been observed in other areas of Africa (including elsewhere in Namibia), as the population of elephants, domestic stock and people increase so too will the conflict for resources, especially water and vegetation.

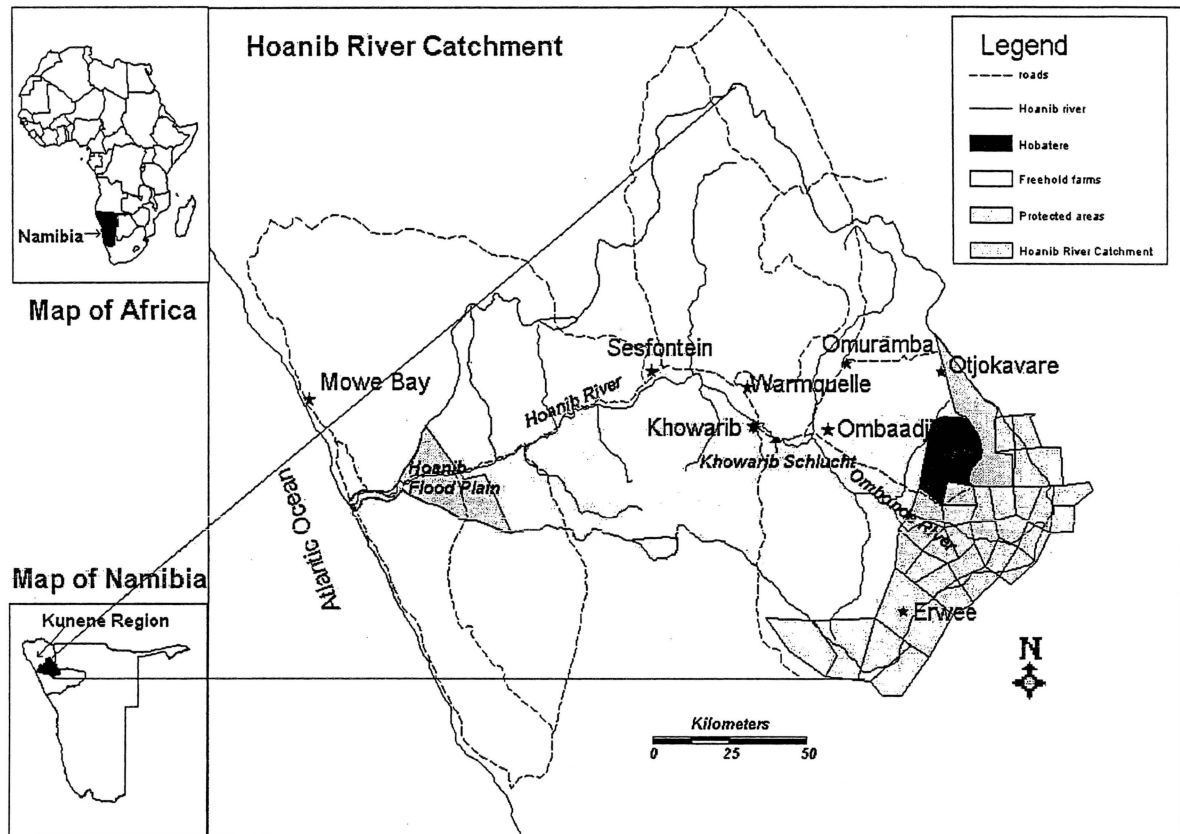


Figure 1: Location of the Hoanib River catchment

METHODS

ELEPHANT DATABASE

The elephant database was developed in conjunction with Barbara Patterson who, as a consultant, produced the database on which photographic and key characteristics of the elephants were stored. Once an elephant was identified and characterised (see attached identification sheets in Appendix A), its bio-data (tusk size and shape, ear notches and holes, tails hair etc.) were entered into a Microsoft Access database.

One of the main features of the database was that it allowed for the comparison of unknown elephants with those already entered into the database by performing a search on the unknown individuals bio-data. This search could be conducted with either a clear head shot photograph of elephant (right, left and front head photos, including the ears), or it could be taken from completed data sheets.

It was possible for the researchers to update all files, as more information became known and changes occurred in relation to a particular individual. For example if an individual broke a tusk, then the date that the tusk was first noticed as being broken was also entered. Similarly, if a photograph or completed identification form became available, then this new information could be scanned into the database, to update the information.

While the database is still in an experimental phase, there are plans to expand it to include all the animals in the western region of Namibia. In addition to being on record at the Desert Research Foundation of Namibia (DRFN), the database will be handed over to MET, other NGOs, Community Based Organisations (CBOs), and other interested parties on completion of the project. There are plans to house the re-writeable version of the database within the MET where it can be maintained and updated.

SECTION I

POPULATION SURVEYS

Aerial surveys

For a more detailed description of methods used in the aerial surveying see Pennycrick *et al.* (1972), Norton-Griffiths (1978), and Gibson (1989). Two aerial surveys were conducted in October 1999 and April 2000 over the entire Hoanib River catchment. Two additional surveys of Hobatere Game Park were conducted with MET and Hobatere management in April 1999. The catchment surveys varied between 16 and 18 hours flying time; The area included the Hoarusib river to approximately 15km upstream of Purros and areas to the north of the Uniab catchment. The areas surveyed were along predetermined flight paths (see Figure 2 for detailed aerial survey blocks), covering major river courses, water holes and known wildlife areas. Additionally 20 randomly chosen 3km x 3km grid squares were flown in areas where wildlife were not known to inhabit to get background counts. The combined survey area represents a 4% coverage of the catchment. When wildlife were located, their positions were marked using a Global Positioning System (GPS) instrument and recorded manually.

In all surveys, a minimum of two observers familiar with the terrain and one recorder accompanied the pilot. The plane flew at an altitude of between 100-150 meters above ground level, depending on wind conditions and topography. Whenever possible, the surveys were conducted in the morning or evenings to take advantage of maximum visibility conditions. In addition, morning and evening flying corresponded to the periods when the animals were most active and not hiding under trees to escape the heat of the day.

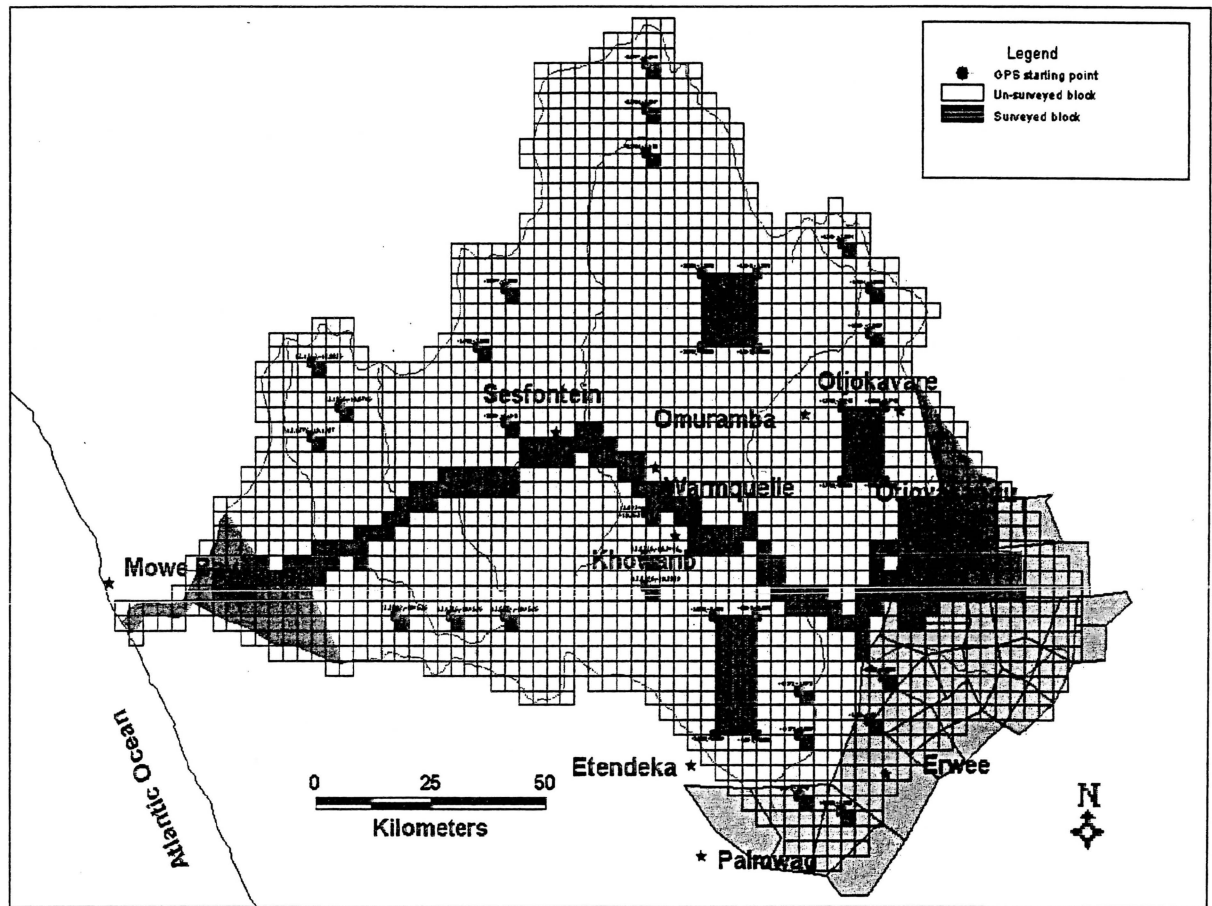


Figure 2: Aerial survey blocks in the Hoanib Catchment (1999-2000).

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Ground surveys

Every two months the researchers undertook systematic ground surveys (from January 1999 until November 2000), driving the length of the Hoanib River on fixed transect routes (see Figure 3 for details of transect route). Community researchers employed by the Hoanib River Catchment Study (HRCS) collected some of the data from the eastern section of the catchment used in this study. The HRCS staff researchers provided the community researchers with basic training in how to sex, age and complete identification sheets (see Appendix B) for the elephants occurring in their areas.

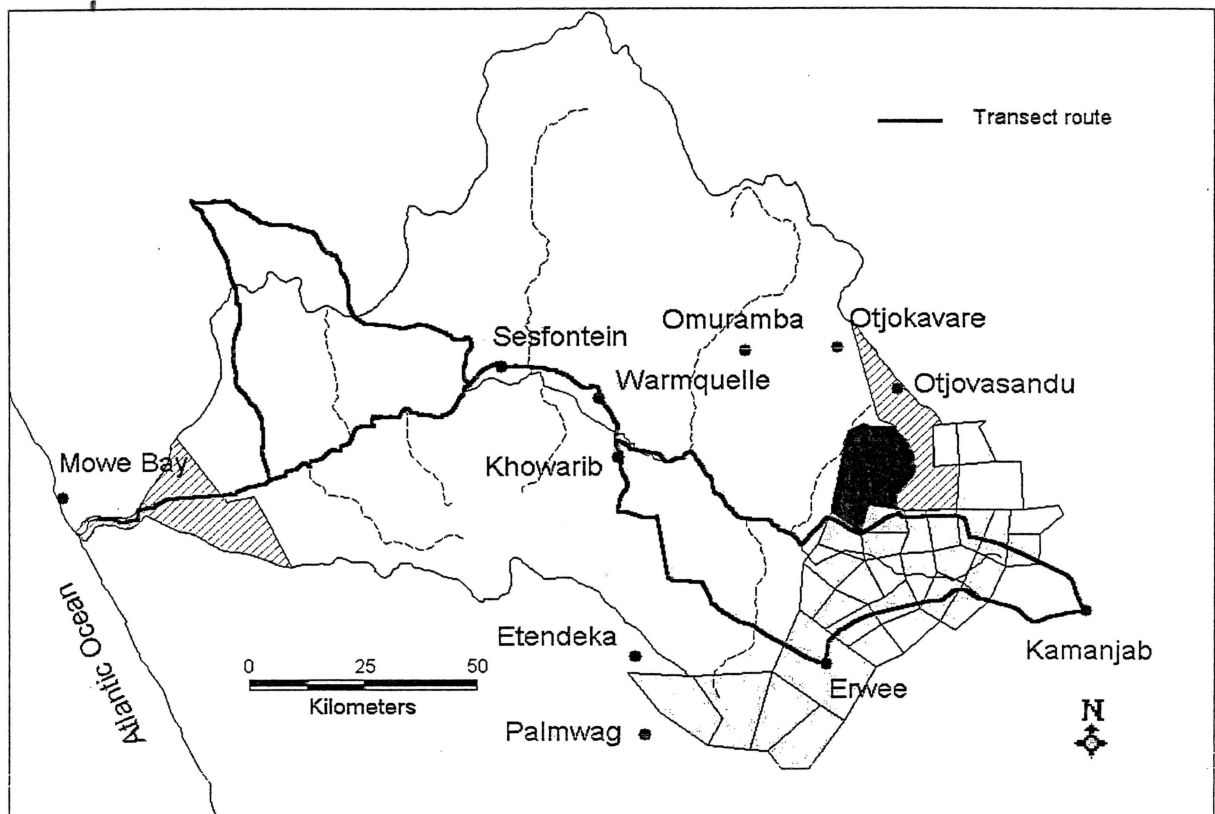


Figure 3: Ground survey transect routes through the Hoanib River catchment.

When elephants were observed during each transect, their location, number, age, sex, general activity and vegetation they were eating were recorded. Transects were driven without break, although it occasionally took more than one day to complete a transect in both the eastern or western sections of the catchment. Wherever possible, elephants were individually identified, given a systematic nomenclature and characterised using a combination of photographs and identification sheets (see Appendix B). An elephant was only characterised, identified and given a systematic symbol once. During all subsequent observations, it was recorded only by its nomenclature, elephant-elephant associations (if any) and activity. The exception to this being if any elephant broke its tusk or if any additional ear holes or tears were noted, then identification sheets were updated and any changes made to the database.

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INDIVIDUAL IDENTIFICATION

Photographic techniques outlined by Altmann (1974), Douglas-Hamilton and Douglas-Hamilton (1975), Moss (1982) and Sukumar (1989) have been shown to be the most effective means of identifying elephants in the field. These methods require the development of a photographic library of individuals. Photographs, updated at regular intervals as the individuals age, or as new characteristics arise (i.e. broken tusk), are taken from the front, left and right side of the individual. The photographs served a dual purpose as they were added to the data sheets, which were kept in a photo-library for use in the field and added to the computer database in the office. These could then be used as a permanent record of individuals and herd characteristics to be used by other researchers. As the herds increase, they will eventually split up and form subgroups, each of which can then be simply identified and characterised using the photographic record.

Individuals were identified from the photographs using five basic techniques:

Sex

Examination of the head was usually the quickest and easiest method of sexual identification. If the head 'sloped' the animal was a male and if it had a prominent 'bulge' on the forehead, it was female. In addition, the sex of an individual was usually obvious in adults as the males are generally larger in both body and tusk size. However, assessing the sex was much more difficult in younger animals (less than 6-10 years of age). Viljoen (1988), notes that the most reliable method of sexing young elephants was observing the individual while urinating. If the individual urinated forward it was a male, but if it urinated either straight down or backwards it was female. Young males often extend their penises, making sexing easier.

Tusks

No two individuals tusks are the same, in either shape or size. Most elephants are either left or right tusked, favouring one of their tusks when feeding or fighting. Broken and chipped tusks can also be used as diagnostic features.

Ears

These vary in venation, size and the degree of sustained nicks, cuts and holes. Since the nicks, cuts and holes change, they need to be regularly recorded. Occasionally, the cartilage in the ear is broken resulting in a 'floppy ear' and this can be used to identify individuals.

Foot prints

Much like human fingerprints, no two elephant footprints are the same. At birth the grooves and cracks in the pads are virtually non-existent but as the elephant grows older, they become deeper and more defined. In older individuals, who have continually wandered the arid sandy areas, the cracks can be worn smooth over time. It was also possible to estimate the age of an elephant by the size of its footprints.

Tail

In many elephants, the tail may be used as a diagnostic tool as it was often broken or kinked and the amount of hair on each tail varies from individual to individual.

SOCIAL ORGANISATION

Group size

It was necessary to determine elephant group sizes to examine their social organisation and possible environmental influences thereof.

As originally described by Viljoen (1988), the term 'group' was operationally defined as any number of elephants that are closely associated in space and appear to be co-ordinated in their activity at the time of observation. This does not imply specific social ties and, in particular, was not synonymous with family unit characteristics of elephant social organisation. Group size data was collected every second month and was analysed on the basis of three distinct seasons: wet (January to April), cold dry (May to August) and hot dry (September to December) seasons. This allowed the data collected during this study to be compared to the previous studies undertaken by Viljoen (1988).

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Historical data (1981-95) collected by the MET from both ground and aerial surveys were made available to this study. Average elephant group size was calculated from this data and historical group sizes were compared to group sizes obtained during this study. The historical data had limitations as various conservation officers collected it over this period, with greater or lesser degrees of dedication. However, the data did give an indication of the trends in group size over the time period.

Field age/sex determinations

Field age identification used during this study was based upon the works of Laws (1966) and Viljoen (1988); the original Laws age-height classes are presented in Figure 4a. These age-height classes were based on shoulder height measurements taken from elephants in Uganda. Viljoen (1988) used a photographic method to establish elephant shoulder heights. He photographed the elephants against a known background and when the animal had moved off, he again photographed the background with the addition of a measuring stick placed in the elephant's front footprint. According to Laws (1966), the size of males and females are similar for the first 15 years of their lives, after which the males continue to develop physically. In addition, the tusk size of males continues to increase at a faster rate than that of females both in girth and in length. Laws (1966) also states that a calf is able to stand under the front legs of its mother for the first 12 months of its life (see Figure 4b). Viljoen (1988) confirmed these results.

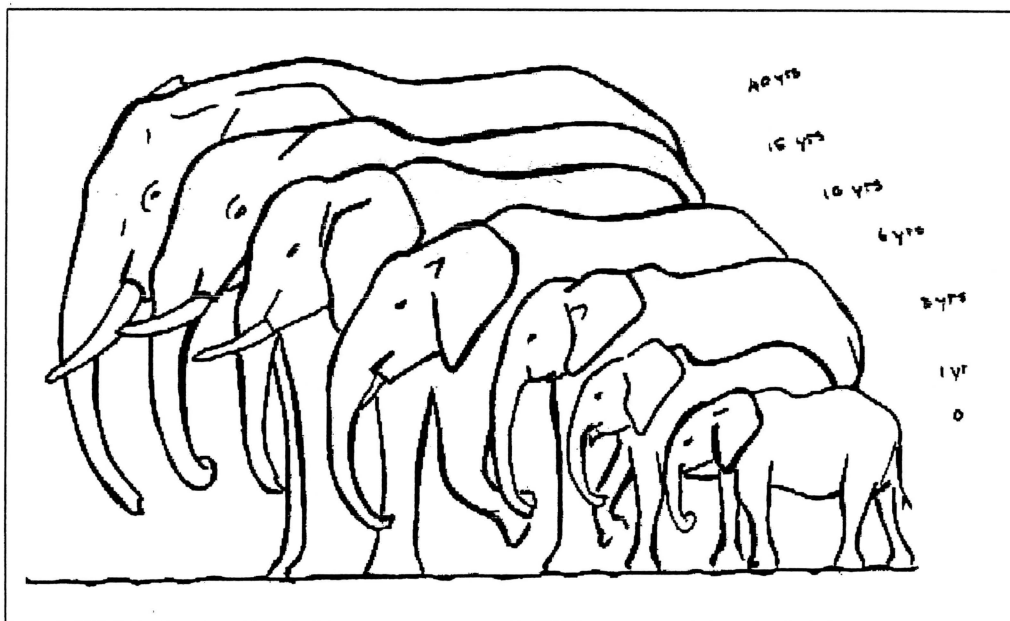


Figure 4a: Field age criteria for female western Ugandan elephants (Source: Laws, 1966)

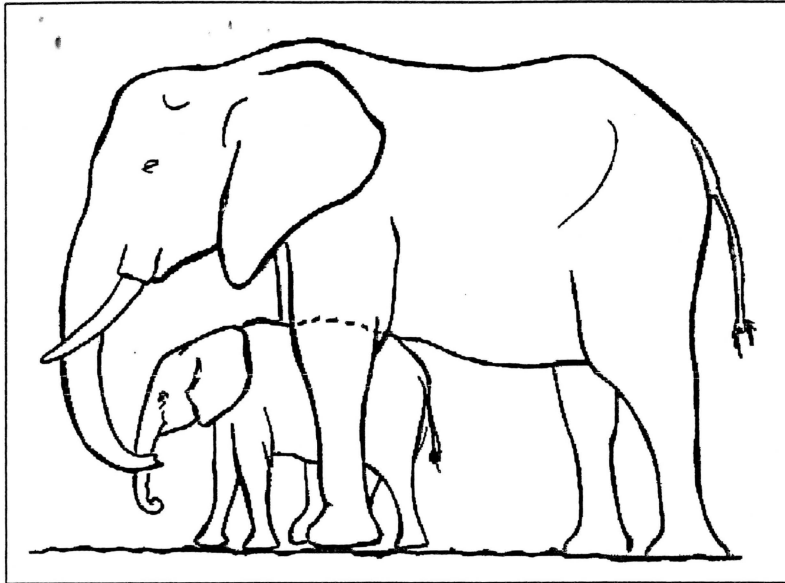


Figure 4b: Relation of average one-year-old calf to average adult female (Source: Laws, 1966).

During this study, elephants were recorded as one of three age-height classes. The reduced number of age classes was used in favour of Laws' traditional age-height classes, as the number of animals observed was relatively low. The age-height classes used by this study were defined as follows:

- Juvenile: up to approximately three years of age with a shoulder height up to their mothers' mouths.
- Sub-adult: up to approximately 15 years of age with a shoulder height up to approximately that of the adult female. As young males are approximately the same size as females at this age it is difficult to distinguish, but distinction can be made on tusks size (males are relatively better developed) and manner of urination (as described earlier).
- Adult: all adult females older than 15 years of age and of relatively equivalent height. Males have generally left the breeding herds by this age but occasionally return to (or form bachelor herds) and can be distinguished by their physical size (much larger than females), sloping forehead and larger tusk size.

SECTION I

Group Organisation

The frequency and composition of elephant groups were gathered from observations made between January 1999 and November 2000. Different elephant groups were defined as follows:

- Bull groups: Composed of only adult males.
- Breeding group/herd: Composed of females of all ages and young males; and
- Mixed groups: Composed of adult males, females of all ages and young males.

In this context, basic elephant social organisation was studied. Operationally, the basic family group in this study was defined as the maximum number of individuals that formed close associations, especially during times of stress (e.g. dry season). They usually co-ordinated their movements and geographical range.

By long-term field observations over the study period, the structure of the family group was determined. This detailed research was only possible in the western section of the Hoanib catchment where the elephant groups were easily identifiable and not as nervous as those observed in the eastern catchment. Sufficient data was not available for the elephants in the eastern section of the catchment.

Mortalities

All mortalities found or reported in the Hoanib River catchment area were recorded and tentatively assigned to one of three age classes; juvenile, sub-adult or adult as previously described. No attempt was made during th

RESULTS

AERIAL SURVEY DATA

The aerial survey data presented in Table 2 represent a combination of the MET data and data collected during this study. The data collected by the Hoanib River Catchment Study Team (HRCST) are based on intensive surveying of known elephant areas, although no attempt was made to apply statistical analysis to the data or present it as representative of the total population of the catchment.

Table 2: Results of the Hoanib River Catchment Study and Ministry of Environment and Tourism aerial surveys in northwestern Namibia (1998-2000)

Date	Survey conducted by	Location/Area	Total number of elephants observed
September 1998	MET	Kunene Region	579
April 1999	HRCST	Hobatere Game Park	24
November 1999	HRCST	Total survey area	70
		Hoanib River Catchment	59
		▪ Eastern Catchment	39
		▪ Western Catchment	20
		▪ Hoarusib River	11
April 2000	HRCST	Total survey area	31
		Hoanib River Catchment	30
		▪ Eastern Catchment	24
		▪ Western Catchment	6
		▪ Hoarusib River	1

SECTION I

GROUND SURVEY DATA

The ground survey data collected during this study are presented in Tables 3 and 4. The data from the eastern catchment (Table 3) includes observations by the HRCST and HRCS community researchers. While the western catchment data in Table 4 were based on observations made by HRCST only, Table 3 and 4 present the total number of elephants observed in each transect, along with the number of sightings and the number of transects undertaken during each month.

Table 3: Ground survey data collected in the eastern Hoanib River catchment, 1999 - 2000

Month	Total number of elephants observed ¹	Number of sightings	Number of Transects
January 1999	1	1	1
March 1999	11	3	1
May 1999	29	6	1
June 1999	26	7	1
October 1999	13	5	1
January 2000	2	2	1
February 2000	6	1	1
April 2000	9	3	–
June 2000	21	2	1
September 2000	1	1	1

¹ Combines data collected by HRCS community researchers

Table 4: Ground survey data collected in the western Hoanib River catchment, 1999 - 2000

Month	Total number of elephants observed	Number of sightings	Number of Transects
January 1999	2	2	1
March 1999	42	10	1
April 1999	6	3	1
May 1999	37	12	2
June 1999	27	13	3
July 1999	27	11	2
August 1999	3	1	1
September 1999	20	7	2
October 1999	8	1	1
January 2000	13	5	1
May 2000	1	1	1
August 2000	2	2	1
September 2000	11	8	1
November 2000	22	9	1

The results from both Tables 3 and 4 indicate that the number of elephants observed per sighting differed depending on the time year. In the eastern catchment, larger group sightings of elephants were observed during May and June, with the smallest group sightings observed during January, February and March. Meanwhile, in the western catchment, larger group sightings of elephants were observed between March and May and from September to November. Smaller group sightings were observed in January, February and from June to August.

SOCIAL ORGANISATION

Historical group size

Historical group sizes are presented in Tables 5 and 6. This data was collated from historical ground and aerial counts of the MET (1981-1995) and the research of Viljoen (1981- 1982).

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Table 5: Historical group sizes in the eastern Hoanib River catchment, 1981-2000

Year	Average group size	Number of sightings	Standard deviation	% Coefficient of variation
1981	20.00	1	0.00	0.00
1984	11.14	7	9.51	85.36
1986	9.67	3	15.01	155.29
1988	9.08	13	10.43	114.88
1989	6.79	28	5.89	86.36
1992	2.00	7	1.91	95.74
1993	3.83	6	6.01	156.88
1995	1.00	4	0.00	0.00
1999	3.05	21	3.83	125.63
2000	3.82	15	3.82	123.12

Table 6: Historical group sizes in the western Hoanib River catchment, 1981-2000

Year	Average group size	Number of sightings	Standard deviation	% Coefficient of variation
1981	4.76	127	9.99	209
1982	5.38	116	12.6	234
1983	25.00	1	0.00	0.00
1984	4.00	1	0.00	0.00
1986	4.42	30	3.59	81.18
1988	5.67	7	5.01	88.35
1989	9.29	24	9.71	104.51
1990	4.36	22	5.04	115.46
1991	2.00	2	1.41	70.71
1992	5.33	21	4.87	91.34
1993	3.67	3	3.79	103.25
1994	1.00	3	0.00	0.00
1997	1.00	1	0.00	0.00
1999	2.96	68	2.50	84.59
2000	2.26	23	2.20	97.29

The data presented in Table 5 indicate that the average group size of elephants in the eastern catchment fell steadily from 1981 until 1992. After 1992, the average group number of

elephants has remained approximately the same. In contrast, the average group size of elephants in the western catchment (Table 6) appears not to have changed significantly since 1981.

Seasonal group size

Historical group sizes can be used for comparison. For example, Viljoen's study (1988) in the western Hoanib (desert-dwelling elephants) can be compared with the present study's results. Table 7 shows seasonal group size data collected by Viljoen (1988) and Table 8 presents data collected during this study for both the eastern and western catchment areas.

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Table 7: Data on seasonal group size of western catchment (desert-dwelling) elephants for 1981- 1982 (Viljoen, 1988)

Season	Mean group size	Number of sightings	S.D.	% coefficient of variation
Wet, 1981	6.69	13	7.85	117
Wet, 1982	9.36	11	9.83	105
Cold dry, 1981	4.40	20	3.33	76
Cold dry, 1982	6.20	34	6.91	111
Hot dry, 1981	4.09	80	2.89	70
Hot dry, 1982	4.72	69	3.95	84

Table 8: Data on seasonal group size for Hoanib river catchment elephants, 1999-2000

Season	Average group size	Number of sightings	S.D.	% coefficient of variation
Eastern Hoanib				
Wet, 1999	2.33	6	2.42	103.81
Wet, 2000	3.42	12	3.68	107.69
Cold dry, 1999	3.60	10	5.17	143.56
Cold dry, 2000	4.71	7	5.38	114.04
Hot dry, 1999	2.60	5	0.89	34.4
Hot dry, 2000	1.00	1	0	0
Western Hoanib				
Wet, 1999	3.00	20	1.97	65.78
Wet, 2000	2.71	7	2.43	89.53
Cold dry, 1999	2.83	39	2.67	94.47
Cold dry, 2000	1.8	6	1.79	99.38
Hot dry, 1999	3.50	7	3.02	86.39
Hot dry, 2000	2.23	18	2.35	105.37

When Viljoen's historical data (1981-82) was compared to the data collected in the western catchment during this study (1999 – 2000), it could be seen that there was a significant decline in the average group size of elephants over all seasons. In addition, the average group size of elephants in the eastern catchment appeared to vary from season to season. There appeared to be an aggregation of elephants during the cold dry season (Av. group size: 3.60

(1999); 4.71 (2000)). This was followed by dispersal during the hot dry (Av. group size: 2.60 (1999); 1.00 (2000)) and wet season (Av. Group size: 2.33 (1999); 3.42 (2000)).

In the western catchment there appeared to be an aggregation of elephants during the wet season (Av. group size: 3.43 (1999); 2.60 (2000)) and hot dry season (Av. group size: 3.50 (1999); 2.23 (2000)). However, during the cold dry season a decrease was observed in the average group size (Av. group size: 2.83 (1999); 1.80 (2000)).

Field age/sex determinations

The age and sex distribution of elephants observed in both the eastern and western catchment and their seasonal occurrence is presented in Table 9. Little long-term data was available on age/sex ratios of desert-dwelling elephants and only Viljoen (1988) has assigned age categories to this group of elephants. No attempt was made to allocate elephants observed during this study in the same age classes defined by Viljoen.

Table 9: Seasonal age and sex distribution of elephants in the Hoanib River catchment, 1999-2000

Month	Total No. of elephants observed	No. of observations	No. of adult males	No. of adult females	No. of sub-adults	No. of juveniles	No. of breeding herds
Eastern Catchment							
Wet, 1999	12	3	7	3	1	1	1
Wet, 2000	17	3	5	4	7	1	2
Cold dry, 1999	55	11	24	15	9	7	3
Cold dry, 2000	21	2	7	7	4	3	2
Hot dry, 1999	13	5	9	3	1	0	0
Hot dry, 2000	1	1	1	0	0	0	0
Western Catchment							
Wet, 1999	54	15	13	17	13	7	4
Wet, 2000	13	5	3	5	2	3	2
Cold dry, 1999	94	37	30	36	18	16	4
Cold dry, 2000	3	3	3	0	0	0	0
Hot dry, 1999	28	8	9	10	4	5	3
Hot dry, 2000	33	17	12	8	8	5	4

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The data collected during this study was not sufficient to draw any definitive conclusions on the age distribution of elephants living in the catchment. The ability of the community researchers to sex non-adult elephants was poor. As a result of this, sexing data for sub-adult and juvenile elephants was unreliable and has not been included in this study.

The data presented in Table 9 indicated that there was a seasonal difference in the populations in both the eastern and western Hoanib catchment areas. In the eastern catchment there appeared to be fewer breeding groups in the area during the hot dry and wet season with the greater number of breeding herd observations being recorded during the cold dry season. While in the western catchment this appears to be reversed.

The ratio of adult males to adult females to sub-adults to juveniles varied significantly from the eastern to western sections of the catchment. In the eastern section of the catchment, the ratio of adult males to adult female to sub-adults to juveniles was 4.4:2.6:1.8:1.0, while in the western section of the catchment the ratio was 1.8:2.1:1.3:1.0. The adult female (greater than 15 years of age) to juvenile (less than three years of age) ratio appeared to be slightly greater in the western than in the eastern catchment areas. In the eastern catchment a ratio of 2.6 adult females to 1 juvenile was observed while in the west, a ratio of 2.1 adult females to 1 juvenile was recorded.

Group organisations

Sufficient data was not available from the eastern catchment to make any assumptions about group organisation. However, a significant amount of data about the elephants in the western catchment was available, not only from this study but also from historical data. Established family (mother/offspring) relationships observed in the western Hoanib are shown in Table 10.

Table 10: Identified family units in the western Hoanib River

Group size	Identified adult female	Identified sub-adult	Identified juvenile
2	WHF-3		WHF-3/a1
4	WHF-4	WHF-4/a1	WHF-4/a2, WHF-4/a3
4	WHF-7	WHF-7/a1	WHF-7/a2, WHF-7/a3
2	WHF14		WHF-14/a1

In the case of WHF-4, the two juveniles were thought to be twins. Although the adoption of orphaned or abandoned juveniles by other females has been observed (Douglas-Hamilton, 1975; Moss, 1982), no other adult female was observed to have abandoned an offspring nor was any adult female mortality reported during the time of the study.

The group organisations observed between female and male elephants occurring in the western Hoanib River are shown in Tables 11 and 12, respectively. Historical male group associations in the western Hoanib are presented in Table 13 and data collected during this study on male associations are presented in Table 14. An historical comparison between female groups was not possible, as the herd identifications used by Viljoen (1988) could not be recognised during this study.

Table 11: Adult Female associations (as a percentage) in the western Hoanib River catchment, 1999-2000

Adult	N	WHF1	WHF2	WHF3	WHF4	WHF5	WHF6	WHF7	WHF9	WHF10	WHF11	WHF12	WHF13	WHF14	WHF15	Bulls
WHF1	12		26%	8%	8%	8%	8%		8%	8%		8%		8%		
WHF2	14	23%		8%		14%	14%		14%	14%		8%		8%		
WHF3	12	26%	8%		8%	16%			8%			8%		26%		
WHF4	12	8%		8%	26%	8%									8%	40%
WHF5	10	20%	20%	10%	10%		10%			10%		10%		10%		
WHF6	8	24%	24%	13%		13%									13%	13%
WHF7	2															
WHF9	3	33%	33%	33%												
WHF10	4	25%	50%			25%										
WHF11	1												100%			
WHF12	5	20%	20%	20%		20%							20%			
WHF13	1										100%					
WHF14	13	23%	23%	23%		8%									23%	
WHF15	4				25%		25%							50%		

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Table 12: Adult male associations in the western Hoanib River catchment, 1999-2000

Bull I.D.	Sample size	Single associations	Associations in pairs	Associations in groups >2	Associations with mixed sex groups
WHB1	6	67%	17%		17%
WHB2	2		50%		50%
WHB3	6	67%	17%		17%
WHB4	1				100%
WHB5	2	50%	50%		
WHB6	2	50%	50%		
WHB7	2	50%	50%		
WHB8	1		100%		
WHB10	1				100%
WHB12	2	100%			
WHB13	1	100%			
WHB14	1	100%			

Table 13: Historical adult, male elephant associations in the western Hoanib River catchment, 1980-83¹

Season	Sample size	% of single bulls	% of bulls in pairs	% of bulls in groups >2	% of bulls in groups of mixed sex
Wet, 1980-83 ¹	48	16.7	16.7	0.0	66.7
Cold dry, 1980-83 ¹	96	16.7	29.2	29.2	25.0
Hot dry, 1980-83 ¹	141	32.6	32.6	21.3	22.0

¹ Data obtained from Viljoen (1988).

Table 14: Adult male elephant associations in the Hoanib River catchment, 1999-2000

Season	Sample size	% of single bulls	% of bulls in pairs	% of bulls in groups >2	% of bulls in groups of mixed sex
Eastern Hoanib					
Wet, 1999-2000	11	54	0	18	28
Cold dry, 1999-2000	11	28	9	9	54
Hot dry, 1999-2000	5	20	40	20	20
Western Hoanib					
Wet, 1999-2000	15	54	0	0	46
Cold dry, 1999-2000	30	79	10	0	11
Hot dry, 1999-2000	17	65	6	0	29

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The results from Table 11 indicated that there are very few permanent associations between adult females in the western Hoanib catchment. Aggregations of females do occur but these are generally very loose groups with adult females often being associated with several different females over a relatively short period of time. Only one adult female (WHF-7) and her offspring were never observed to interact with any of the other females in the river.

Adult male associations (Table 12) in the western Hoanib river were either single or pair associations. There appeared to be only two adult males who were 'permanently' in the river (WHB-1 and WHB-3), with all other males were thought to be transitory. Adult males were not observed to form bachelor groups during this study. This trend is different from historical observations (Table 13) and the present study in the eastern section of the catchment (Table 14) where bachelor groups seasonally made up to 29.2% and 20% of observations respectively.

MORTALITIES

Table 15 shows the mortalities observed in the Hoanib Catchment during 1999 – 2000. All mortalities were recorded in the eastern Hoanib catchment. Only four of these mortalities can be attributed to natural causes and two elephants were considered 'problem animals' by MET and consequently shot.

Table 15: Observed elephant mortalities in the Hoanib River catchment, 1999 - 2000

Date	GPS co-ordinates		Locality	Cause of death	Age class of elephant
Mar 1999	-19.31581S	13.96347E	Khowarib Schlucht	Natural causes	Juvenile
May 1999	-19.35988S	13.90969E	Ombonde River near Serengeti	Natural causes	Juvenile
Jun 1999	-19.39210S	13.19323E	Eendrag post	Shot by MET	Adult male
Jun 1999	-19.45927S	13.28000E	Eendrag	Shot by MET	Adult male
Jan 2000	-19.02216S	14.14391E	Otjokavare	Natural causes	Juvenile
Apr 2000			Near Omuramba	Natural causes	Adult male

DISCUSSION

POPULATION STUDIES

The results obtained from both transect and aerial surveys indicated that the population of elephants resident in the Hoanib catchment area varied both seasonally and annually. Annual fluctuations in elephant populations are dependent on the occurrence and quantity of rainfall within and outside the catchment. However, seasonal variations in populations appeared to be linked to the relative abundance of food and disturbance factors caused by human populations in the immediate area.

In the eastern Hoanib catchment, greater numbers of elephants were observed during the wet season and for several months after the rains. This was probably linked to water and food availability in the veld at this time. While elephants are predominantly browsers during periods of the dry season, they will readily graze when green grass becomes available during and immediately after the wet season.

As grazing and browsing are available in areas away from the rivers, elephants in the eastern catchment appeared to spend the majority of their time spread throughout the veld and into the mountains. Viljoen (1988) observed similar patterns of movement during his study thus supporting this observation. During the hot dry season (August to October), male elephants were regularly observed in the dry riverbeds sheltering from the heat under large *Faidherbia albida* trees. When the *Faidherbia albida* fruit matures (August/ September), increased numbers of elephants (as well as other wildlife) were observed in the riverbed. This feeding aggregation of elephants during times of local food abundance has been observed by a number of authors throughout Africa (Viljoen, 1988; Barnes, 1983; Western and Lindsay, 1984). Elephants in this area tended to remain in the riverbeds during the hot dry season. At the onset of the wet season, they moved back onto the plains to graze and browse on the newly germinated and recently sprouted vegetation.

An interesting observation was made in October 1999 at the onset of the wet season. The day before the rains, during an aerial survey, the elephants were observed only in the dry Hoanib riverbed. The morning after the first rains, no elephant was observed in the Hoanib river, but they were observed on the tops of the mountains to the south-east section of the catchment area. This would indicate that the elephants had moved immediately with the rains to an area

approximately 30-50km away. They were observed to be browsing on vegetation in areas that would normally not be readily accessible due to the ruggedness of the terrain and unavailability of water. It is unclear what the major attraction was for elephants in these areas and why, after the first rains, they moved so rapidly into these areas. Some of the *Commiphora* species sprout shoots soon after rains but the immediate movement of the elephants would not give the plants long enough to sprout. Certainly, water would not be a limiting factor in these areas immediately after rains, but the shallow pools formed in the rocks would only last a short period of time. Elephants were not observed in the southeastern mountain ranges at any other time during this study.

Fluctuations in the occurrence of elephants were more clearly defined in the western section of the catchment than in the east. There appeared to be a defined seasonal fluctuation with the greatest number of elephants observed during the hot dry and wet seasons. The increase in numbers during the hot dry season was thought to be associated with the ripening of the *Faidherbia albida* seedpods. At this time of year, there was little other nutritious grazing or browsing available in the western Hoanib River catchment.

During the cold dry season, between fourteen and sixteen elephants appeared to be permanently associated with the western Hoanib river, around the fresh water springs at Dubis (22km west of Sesfontein). The number of elephants expanded to an observed maximum of 42 elephants just after flood events when fresh water was available and vegetation more plentiful along the riverbed. Flooding of the lower section (western section/floodplains) of the river provided grazing in areas that are normally devoid of edible vegetation. It also provided fresh drinking water in close proximity to the grazing. Without the regular flooding events, little edible vegetation would be available in this area with the nearest fresh water spring approximately 30km from the floodplains. A saline spring (Auses) adjacent to the floodplain was usually used by elephants for bathing only and not for drinking.

After the floodplain filled with water and the annual grasses had matured, there was an observed movement of some of the elephants from the Dubis section of the river toward the floodplain. Other elephants had been observed to move from the Hoarusib River to the Hoanib floodplain at this time. Viljoen (1988) and others have observed large groups of elephants crossing between the two rivers during the wet season, however during this study no such mass movements were observed. Occasionally family groups or lone adult males have been observed moving between rivers but the group sizes were significantly smaller than those observed by Viljoen (1988).

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While the exact number of elephants observed in the western section of the catchment varied both seasonally and annually, the total numbers of elephants observed during this study was approximately the same as observed by Viljoen (1988). Viljoen reported 75 desert-dwelling elephants in the Hoarusib, Hoanib and Uniab river catchments in 1981/82, while during this study a maximum of 42 elephants were observed in the western Hoanib catchment. This shows that the population of the desert-dwelling elephants has remained stable for the last twenty years. The elephants also appeared to be spending less time in the Hoanib River and more time in the Hoarusib than at the time of Viljoen's study. The local residents of Purros have reported longer residence times of elephants in the Hoarusib River.

Two aerial surveys of the catchment were conducted in October/November 1999 and April 2000 in an attempt to establish distribution and relative density of elephants throughout the area. The same transects were flown during both surveys and the same observers were used.

The October/ November 1999 survey was conducted prior to and just at the onset of the wet season. Fifty-nine elephants were observed in the Hoanib Catchment (39 in the eastern catchment and 20 in the western catchment), with 11 additional elephants seen in the Hoarusib river. The 1999-2000 wet season saw the best catchment-wide rainfalls recorded since 1976. The 1995 rains were exceptional in the western section of the catchment but the eastern section received only average rainfall (data on file). During the aerial survey flown in April 2000, only 30 elephants were observed: 24 in the eastern catchment, and six in the western catchment. Only 1 elephant was observed in the Hoarusib River. While the deficiencies of aerial surveying are well recorded (Pennycuik *et al.*, 1972; Norton-Griffiths, 1978; Jachmann, 1991), the difference in numbers recorded during these surveys was significant. The above average rains are thought to have caused elephants to move out of the Hoanib catchment.

While little is known about the movement of the elephants in the eastern section of the catchment, the western Hoanib elephants are much better studied and understood. However, after the heavy rains of 1999/2000 only six elephants were observed in the western Hoanib catchment and only one in the Hoarusib river. Where the elephants moved to or came from and their residence time in these locations remains unknown.

Similarly, in November 2000, 22 elephants (four breeding groups) were recorded in the western Hoanib catchment, yet two weeks prior, only six elephants (one breeding group) were observed. Three breeding groups had returned to the western section of the river in two

weeks. These groups had not been observed in the western Hoanib catchment for nine months.

SOCIAL ORGANISATION

Group size

The historical data was obtained from MET and Viljoen (1988) and showed that the average group size of animals observed in the Hoanib catchment area had decreased over time.

The decrease in group size was most marked in the eastern catchment where the average group size had fallen from 20 (1981) to approximately 3.82 (2000). While data available for the eastern catchment was not as extensive as for the western Hoanib catchment, the trend was significant. According to Viljoen (1988), poachers shot sixty elephants (33% of the estimated population) in the eastern Hoanib catchment between 1980-1982. Under this kind of poaching stress, elephants tend to form larger group sizes (Laws, 1974; Laws, *et al.*, 1975; Eltringham, 1977; Abe, 1982; Poole, 1989) and this was reflected in the historical observations. Since that time, poaching stress has been reduced and with an increased tolerance for elephants displayed by the communities living in the area, group sizes have decreased to their current levels. The tendency of elephants to form larger groups has occasionally been observed at the onset and during the wet season. It was thought that these feeding aggregations are similar to those observed when the *Faidherbia albida* seedpods ripened, but in this case the elephants fed on the annual grasses that grow during and after the wet season.

From 1981 to 2000 the average group size of elephants in the western Hoanib catchment varied in the range of 1 to 25, but no marked trend was apparent. The abnormally large group size of 25 was observed in 1983 and was thought to be a response to poaching pressure. Apart from this one observation, the average group size of elephants has remained relatively low over the last 20 years. The average group size observed in 1981 was 4.76 and in 2000, it was 2.26.

In the western Hoanib catchment there appeared to be a seasonal trend in average group size. With a tendency for smaller group sizes during the cold dry season (average group size: 2.83 (1999); 1.80 (2000)) with aggregations of individuals during both the hot dry season (average

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group size: 3.50 (1999); 2.23 (2000)) and wet season (average group size: 3.43 (1999); 2.60 (2000)). As already discussed, this seasonal aggregation of elephants was thought to be linked to food and water availability. While the data sets are not complete for the entire time line, the data showed that population and group size has remained approximately the same over the last 20 years. Small group sizes similar to those observed in the western Hoanib catchment have been reported by White *et al.* (1993) for forest elephants in Gabon. There the average group size reported was 3.5 with groups larger than eight being exceptional. The authors suggested that smaller family groups were better able to exploit the patchy available resources in a forest (e.g. fruit) than larger groups, a situation similar to that observed in the western Hoanib catchment.

Field age/sex ratios

The results indicated that in the eastern section of the catchment adult males were seen more frequently than adult females (ratio 4.4:2.6) and breeding herds. The greater human population living in the eastern catchment and the disturbance caused by this association had probably caused the skewing of age/sex distribution in this area. Adult males appeared to be less vulnerable to disturbance than adult females and breeding herds.

By contrast, the proportion of adult males to adult females in the western Hoanib catchment was approximately 1:1. This implied that there was a normal distribution of sexes in the western catchment. It further indicated that this population was relatively stable and undisturbed or untroubled by humans. In addition, more observations of breeding herds were recorded in the western section of the catchment than in the eastern.

The ratio of adult females to juveniles was slightly greater in the western sections than eastern section of the catchment, 2.6:1 and 2.1:1, respectively. This showed that the western population was breeding at a slightly faster rate than the eastern population. However a longer-term study would need to confirm whether this was an accurate assessment of the populations. This result was in contrast to the breeding ratios reported by Viljoen (1988), where the western population was breeding at a much slower rate during 1981-1983, than any other population group studied. The difference in breeding was probably due to the disturbance associated with poaching and an arid climatic cycle at the time of his study.

Group organisation

Little group data was available either historically or gathered during this study to show elephant associations in the eastern sections of the catchment. Far more group data had been gathered on the elephants in the western Hoanib catchment. The western elephants were far more approachable and were "confined" to areas in the riverbed where vegetation and water were available. These factors combine to make it much easier to locate and study them. The elephants in the eastern section were generally shy with large flight distance (in excess of 200 meters) making them difficult to approach and observe. In addition, vegetation and water sources in the eastern Hoanib catchment were not confined to the riverbeds but widely distributed. This allowed the elephants to have larger and more flexible home ranges. The only complete data sets collected during this study were those for the western section of the catchment.

Herd relationship between adult females and their older offspring were extremely difficult to identify and monitor. It appeared that the adult females formed loosely bonded groups, but they spent equal amounts of time in the presence of all other females. There appeared to be no strong bonding within and between the herds as reported from other parts of Africa (Douglas-Hamilton, 1975; Leuthold, 1976; Leuthold, 1977; Moss, 1982). Viljoen (1988) reported similar loosely associated groups but within recognised clans. The only relationships that could be identified were adult female and younger offspring (up to about 15 years of age) associations of which four were identified and studied. It appeared that in one case (WHF-4) two of the three offspring still associating with the adult female were twins.

Sibling relationships were difficult to identify and only one relationship was established during the course of this study. This sibling association was between two tuskless females (WHF-3 and WHF-15) and they are thought to be the offspring of an older tuskless female (now dead) previously studied by Viljoen, (1988) and Loutit, B. (pers. com. 1999).

There appeared to be a spatial separation of groups in the western Hoanib. There are some groups that seasonally occupied the floodplains during the wet season (WHF-7) and those (WHF-1, WHF-2, WHF-3, WHF-4, WHF-5, WHF-6, WHF-9, WHF-10, WHF-11, WHF-12, WHF-13, WHF-14, WHF-15) that appeared to be more permanently associated with the wetlands around Dubis. There appeared to be little interaction between these two groups. The behaviour of adult female groups towards each other appeared to be neutral or even at times amicable, but certainly the elaborate social greeting and interactions described by other

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authors (Douglas-Hamilton, 1975; Leuthold, 1976; Leuthold, 1977; Moss, 1982) were not observed during this study.

The western Hoanib catchment adult male elephants appeared to be more 'free-ranging' than the adult females and only two bulls (WHB-1, WHB-3) appeared to be permanent residents in the western section of the river. While all other bulls' residence times appeared to be much more transitory.

During this study, the western Hoanib catchment bulls were observed singly or in pairs but at no time were bulls observed in groups greater than two. This result differed from those reported by Viljoen (1988) who observed group association (>2) in bulls up to 29.2% of the time in the cold dry season (1980-83) in desert-dwelling elephants. Viljoen's study was undertaken during a period of high stress for elephants. Not only was there extensive poaching in the area but it also coincided with an arid climatic cycle.

In contrast to the western bulls, the eastern Hoanib catchment bulls were observed to associate in groups larger than two for up to 20% of their time. As already discussed, the eastern elephants are subjected to greater human disturbance and hunting pressures than those of the west, which was thought to be a probable reason for the aggregation of adult males.

MORTALITIES

Only six elephant mortalities were recorded in the catchment area during the last two years. Four of these mortalities were thought to be of natural causes. Three of the recorded natural cause mortalities were juvenile elephants (0-3 years), with only one adult male (>15 years) reported as dying in a similar manner. Two adult male elephants were shot as 'problem animals' by MET staff. Professional hunters (on quota) shot another two adult male elephants, to the south of the Hoanib river catchment during the 1999 and 2000 hunting seasons. The sustainability of removing five adult males (two problem animals, two hunted and one from natural causes) in two years from such a relatively small population (between 80-120 elephants) with a maximum recruitment rate of 3.5% (Sikes, 1971; Viljoen 1988) should be investigated further.

ADDITIONAL OBSERVATIONS

While observing a herd of seven elephant 4km south of Sesfontein during the middle of day (temperature approximately 40° C) on the 9 September 1999, two interesting observations were made of mechanisms used by the elephants to cool themselves in hot conditions. The adult males (two) regurgitated water and sprayed themselves every 4-7 minutes over a 2-hour period. The adult female (one) was seen to do this only twice during the observation period, while the calves and young adults were not observed to regurgitate water and spray themselves at all. In addition, after urination the adult female and two sub-adult elephants scooped up the wet sand and threw it over themselves.

PROBLEM ELEPHANT CONTROL

Officers from the MET shot an adult female elephant (WHF-4) in Sesfontein on 10 September 1999 for crop raiding. According to the officers, the elephant charged the vehicle as they were trying to move the elephants back to the river. The herd in question had been observed for two hours the previous day by the HRCS staff researchers from a distance of 20-50 metres. The group of elephants in question remained extremely calm during the whole period of observation showing no aggressive behaviour at all. The herd consisted of seven elephants, two adult males, one sub-adult female, one sub-adult male, one adult female (WHF-4, still lactating) with three calves (1 approx. 6 and 2 approx. 2 years of age). WHF-4 was a well-known female in the western Hoanib river catchment and had been studied for a long period of time by a number of researchers. WHF-4 has been observed numerous times by the HRCST during the past two years at various locations along the Hoanib River, predominately to the west of Dubis.

The range of these elephants had been observed to be increasing and it seemed inevitable that conflict with the farmers in the area would occur. However, these researchers believe that to shoot a lactating female elephant with two calves during 'problem animal control' was not warranted (especially as there were two adult males in the herd). The MET flew in a contract veterinary surgeon (H.O. Reuter), their own game capture unit and attended to the wounded elephant. The team treated an injury to the right shoulder and the left rear leg. The elephant recovered well from these wounds and, when last observed, had rejoined her three calves.

CONCLUSION

Preliminary results pose some interesting questions. Many questions revolve around the long-term movements of elephants in both the eastern and western catchments and the expansion or re-establishment of their old ranges. Herds in the western catchment appear to be very loosely associated and there appears to be a greater residence time of elephants in the Hoarusib River than reported by Viljoen (1988). The social organisation seems unusual and our understanding of this would benefit any future conservation of elephants in the western catchment. Very little is still known about the eastern elephants - their number, ranges, residence time and age structure remain uncertain.

Several questions remain unanswered about the effect of cropping (either problem animal control or professional hunting) on adult male elephant populations, namely:

- Is there a constant influx of new males immigrating into the area from Etosha National Park or are the adult males being shot part of resident populations? A study of the genetics of these elephants would help to solve this question.
- How does this offtake affect the long-term population structures?
- Is professional hunting in conjunction with problem animal control sustainable?
- Is there a greater need for sustainable offtake?

Other management issues include:

- What age groups of elephant are causing the most destruction to local communities?
- What is the tolerance for elephants in the light of the establishment of conservancies over large areas of northwest Namibia?
- How would the conservancies and the communities of the Kunene region like to manage elephants?
- What information does the MET and conservancies require to make informed management decisions about elephants?

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APPENDIX A

(Samples of the Elephant Database)

SECTION I

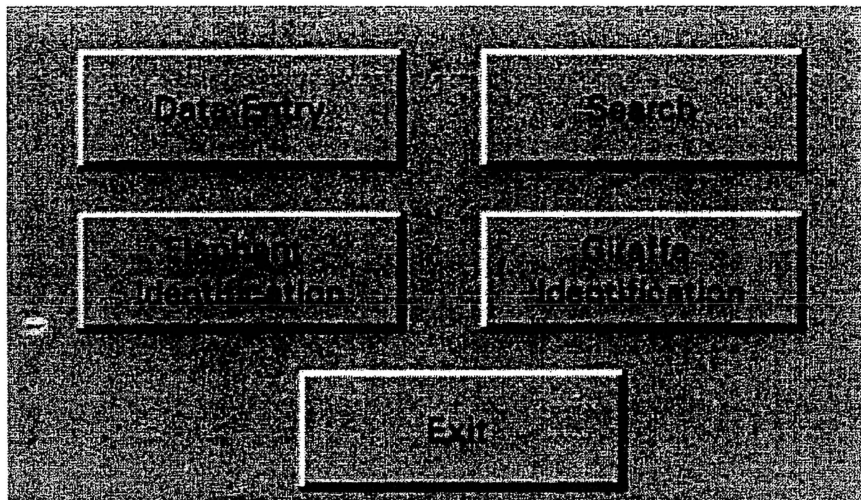


Figure A1: Opening page of database

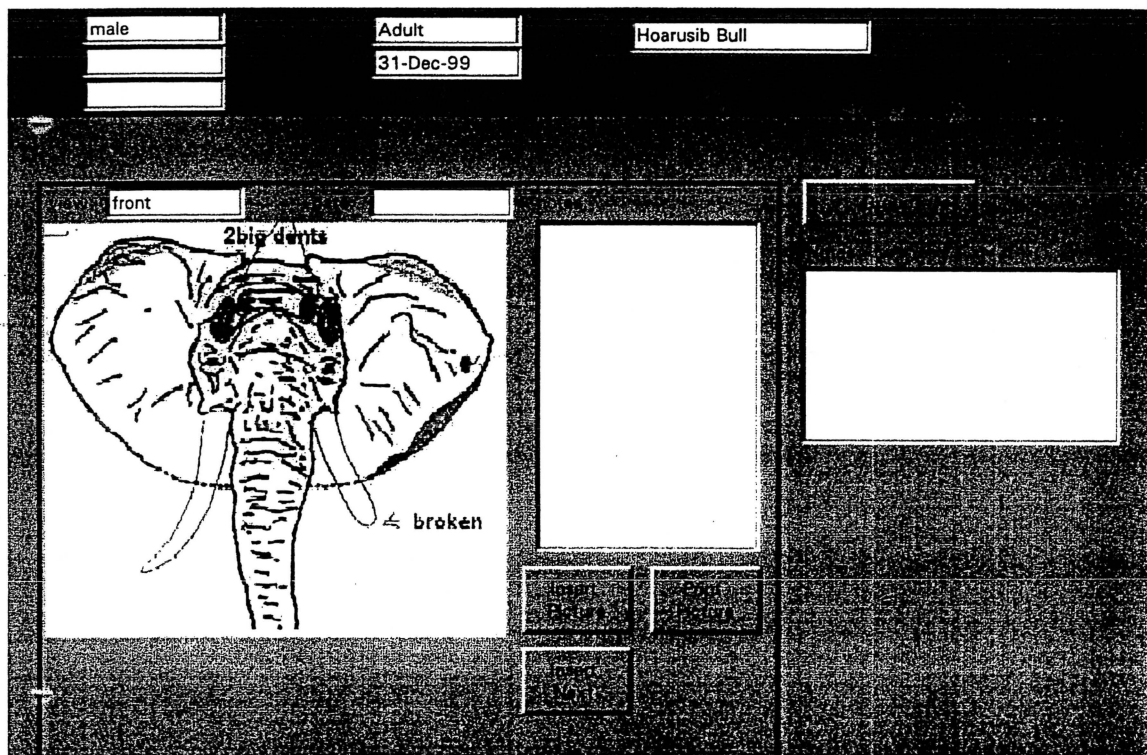


Figure A2: Drawn full frontal head of elephant

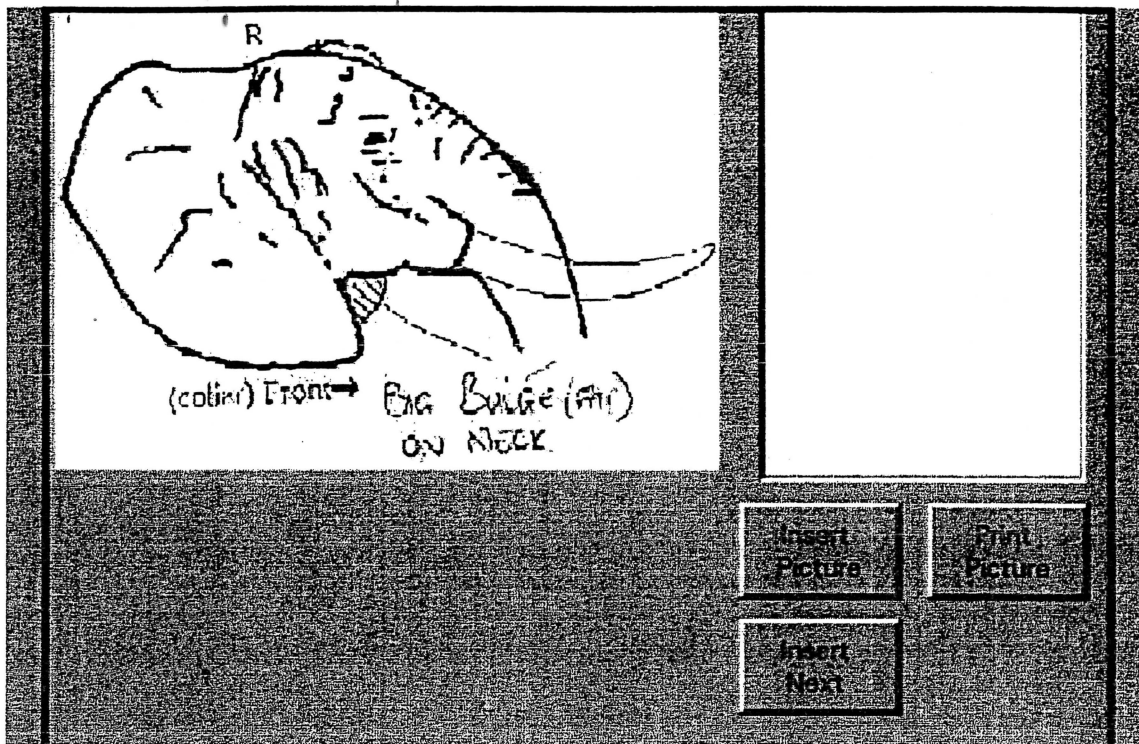


Figure A3: Drawn right profile of elephant

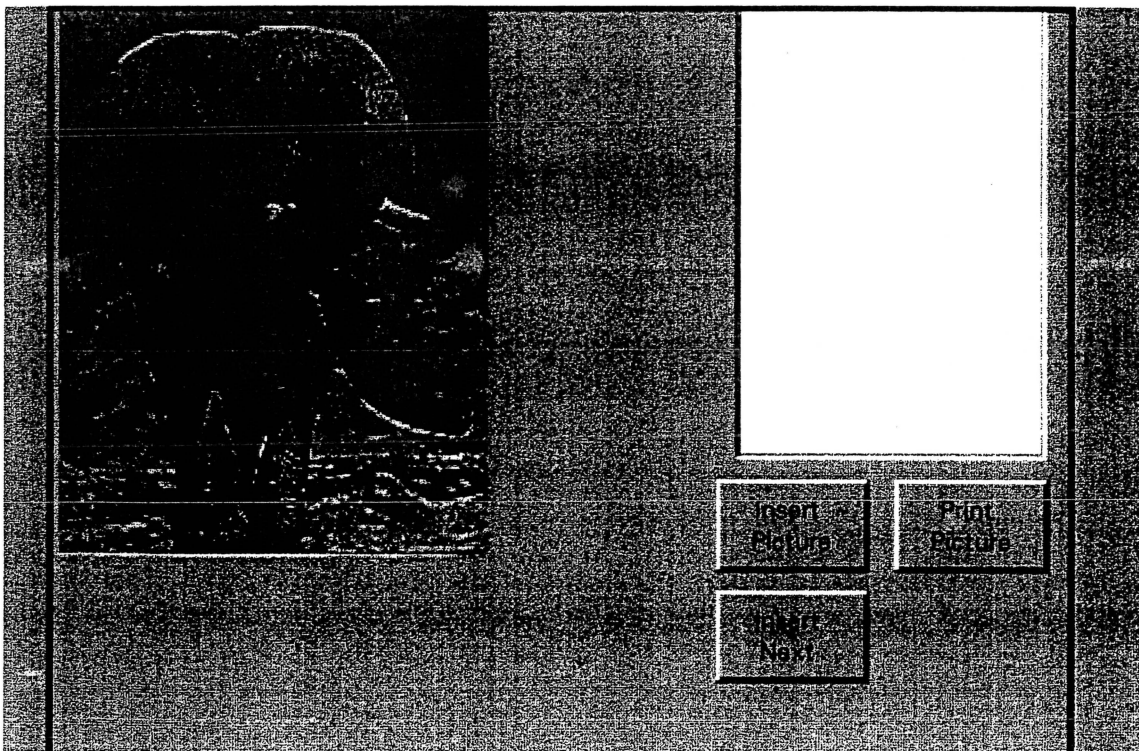


Figure A4: Photograph of front right ear and tusk of elephant

APPENDIX B
(Elephant observation forms)

SECTION I

- ELEPHANT OBSERVATIONS - KUNENE REGION -

ACTIVITY.

Activity of the Majority of Herd/Individual (circle):

Walking

Resting

Drinking

Feeding

Social Interaction i.e. fighting, greeting, etc.....

FEEDING.

Species of Vegetation eaten:.....

Parts of Plant eaten i.e. bark, pods, etc.....

Tree/s used for shade: (i) Species..... (ii) Tree height.....(estimate)

GENERAL CONDITION.

General condition of Elephant (circle):

Poor

Reasonable

Good

Mortality (circle):

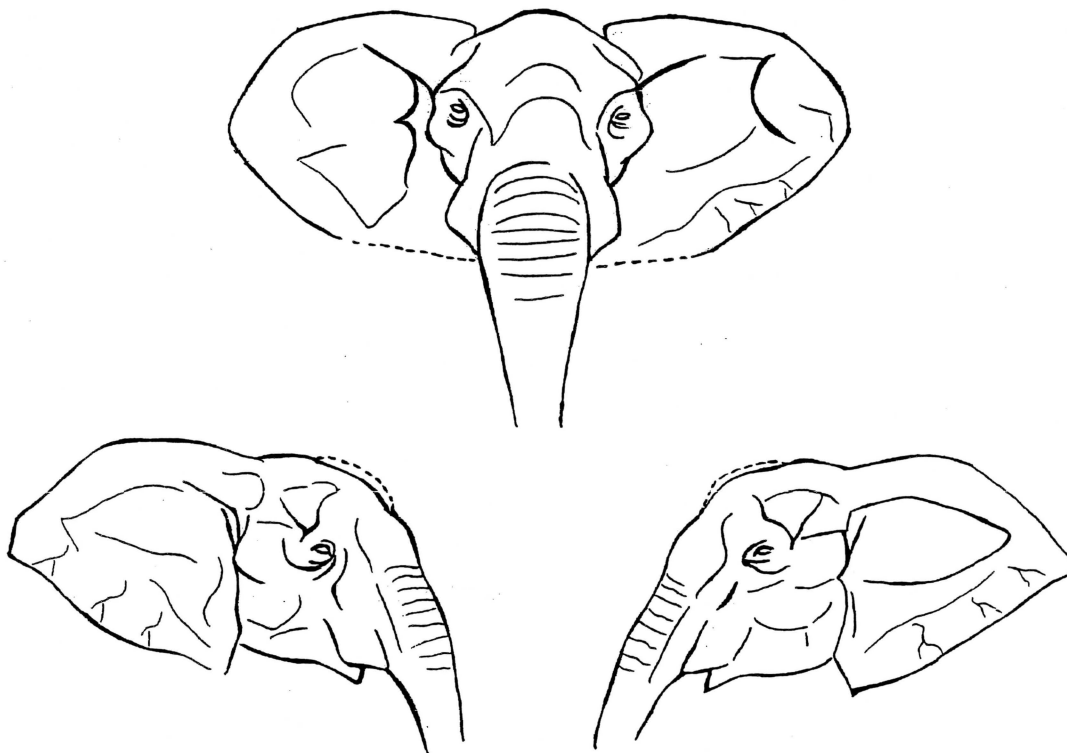
Yes

No

Estimated date of death: Suspected cause of death:

IDENTIFICATION.

SEX.....



All features on Tusks, Ears (notches/holes) and Tail (kinks/hair) **MUST** be drawn in.

A Preliminary Study of the Elephants

- ELEPHANT OBSERVATION - KUNENE REGION -

Date: Observer Name:

Elephant ID Number: Elephant Colloquial Name:

Locality: (i) Farm Name/Number

(ii) Post Name

(iii) Locality e.g. river, spring, etc

GPS Reading:S /E Grid Square/Park Block:.....

Herd Size: Time:

Elephants observed in (circle): Riverbed Riverbank Hills/Mountains

Plains Floodplains

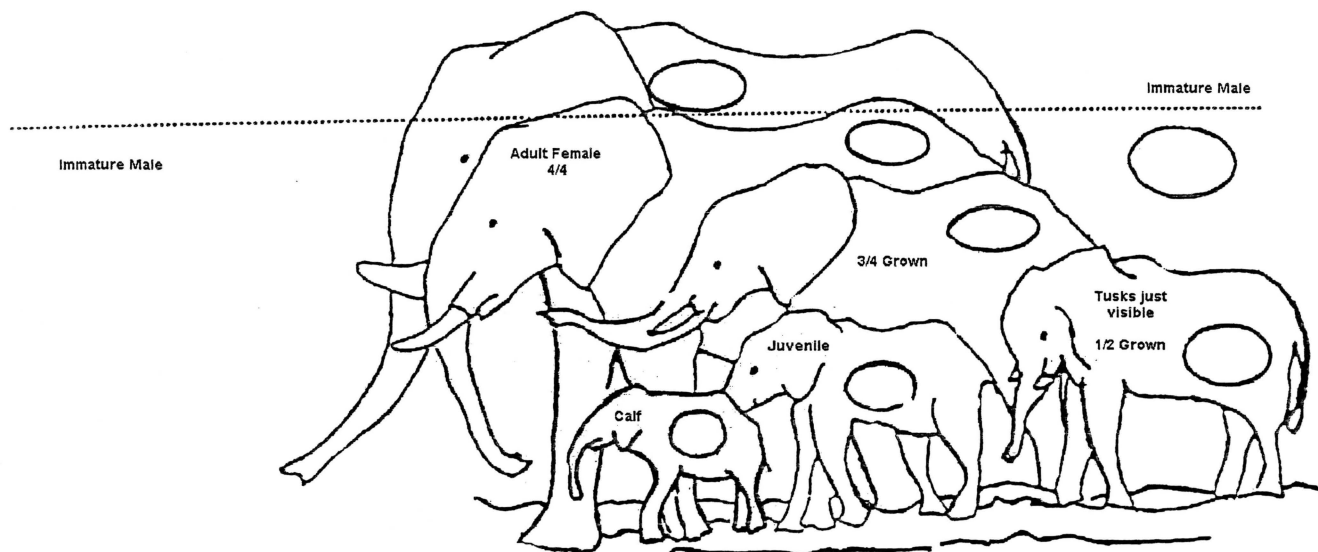
Direction of Movement (circle): N S E W; NW NE SW SE

Flight Distance (from vehicle, humans, etc):.....

MARKED ANIMALS.

(i) Collars

(ii) Photograph for ID (circle) Yes No



NB: 3/4, 1/2 Grown & Juvenile sizes relate to adult

- Spoor Length (cm) -

- Spoor Type (tick) -

Hind Foot

Front Foot



Smooth

Rough

SECTION II

**SEASONAL DOMESTIC STOCK AND WILDLIFE
DISTRIBUTION IN THE HOANIB RIVER
CATCHMENT, NORTHWESTERN NAMIBIA**

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February 2001

ABSTRACT

The seasonal movement of domestic stock (cattle, donkeys, goats, horses and sheep) and wildlife (elephant, gemsbok, giraffe, Hartmann's mountain zebra and springbok) were analysed in the Hoanib River catchment. The data presented in this report is a combination of ground and aerial surveys undertaken by both community and trained researchers. It represents the movement of animals rather than the total number of animals in the catchment area. Animal movements from the wet, cold-dry and hot-dry seasons are presented.

The domestic stock movement and distribution did not vary substantially and appeared to be associated with seasonal and spatial availability of water and grazing. Domestic stock also appeared to be associated with human settlements although there did appear to be a movement of cattle out of the catchment area during the hot-dry season. Although horses and donkeys have the potential to range significantly, they, too, were closely associated with human settlements, as they are predominantly used as 'beasts of burden'.

Of the five species of wildlife reported in this study, only elephant and springbok were found close to human settlements. Gemsbok, Hartmann's mountain zebra and giraffe were found to avoid human settlements and were mostly observed in areas where there was little disturbance from humans and domestic stock. Wildlife appeared to be far more wide-ranging than domestic stock and only elephant and Hartmann's mountain zebra appear to be water-dependent. Wildlife had distinct wet and dry season ranges, concentrating in the Hoanib River during the cold-dry and hot-dry seasons when grazing, and browsing was limited elsewhere.

KEY RESEARCH QUESTIONS

The key research questions for this study focus on the spatial and seasonal distribution and the abundance of wildlife and domestic stock. The study focused on the species that are economically important to the communities and conservancies of the Hoanib River catchment.

- (a) Do the ranges of wildlife and domestic stock overlap?
- (b) Are there distinct seasonal ranges for wildlife and domestic stock?
- (c) What are the management implications for the emerging and established conservancies in the Hoanib River catchment?

BACKGROUND

GENERAL BACKGROUND

Northwestern Namibia

The recent history of the Kunene was shaped initially by the German colonial administration, which, in 1906, declared most of the north-western area, including the area around the Etosha salt pan, as Game Reserve No. 2 (Fuller, 1993). The only effect of this proclamation on human inhabitants was the restrictions on elephant hunting (Owen-Smith and Jacobsohn, 1991).

In 1970, under the South African administration, two thirds of Game Reserve No. 2 was de-gazetted and the north-western area was politically divided into Kaokoland, an ethnic homeland for the Herero and Himba people, stretching north from the Hoanib to the Kunene River. The southern area –from the Swakopmund to Windhoek road in the south and to the Hoanib River in the north - was proclaimed as Damaraland, homeland for the Damara people. The entire coastal strip up to 40km wide was retained as a game reserve and called the Skeleton Coast Park.

Since Namibia's Independence in 1990, Kaokoland and Damaraland have been combined into one administrative area: the Kunene Region. The Kunene region extends from the Ugab River in the south to the Kunene River in the north and is bordered by the Skeleton Coast Park in the west and the freehold farms in the east (up to 120km from the coast). The area south of the Ugab River was incorporated into the Erongo Region.

Between 1979 and 1982, a veterinary cordon fence was erected from east to west, across Namibia, bisecting the Kunene District between the Hoanib and Huab Rivers. The fence was constructed to prevent the spread of two highly contagious livestock diseases viz. foot-and-mouth disease and bovine plueropnuemonia. These diseases are endemic in southern Angola and have sporadically occurred in the northern communal areas of Namibia. The last outbreak of bovine plueropnuemonia occurred in the West Caprivi in 1996 and spread to Botswana. No animals were destroyed in Namibia but 270 000 cattle were shot in the Ngamiland District of Botswana to protect the beef export industry (Leggett, 1996). Livestock and livestock products or products of cloven hoofed wild animals are only allowed to move from north to south through the cordon fences after a quarantine period of 21 days (Owen-Smith and Jacobsohn, 1991). For many years, the veterinary cordon fence has caused conflict between rural farmers north of the fences and those to the south.

The northern farmers believe they have been excluded from the lucrative markets south of the fence, while the southern farmers who are mainly commercial farmers, maintain that they are trying to protect their herds from disease.

Since 1990, the Namibian Government has undertaken several feasibility studies to consider moving the veterinary cordon fence north to the border with Angola. This would alleviate the marketing problems of the northern communal farmers in the Kunene Region. Since the proposed change may entail several social and political problems from other parts of Namibia, it has never been implemented.

Domestic stock

Previous authors (Kinahan, 1991; Owen-Smith and Jacobsohn, 1991) described the traditional herding practices of pastoralists in Southern Africa. In the early nineteenth century, when the first European explorers, settlers and hunters penetrated the Namibian interior, semi-nomadic pastoralism was the dominant socio-economic activity of local peoples. The only areas of Namibia that were not occupied by pastoralists were:

- (a) the Kalahari and Namib Deserts; and

- (b) the floodplains of the Kunene/Cuvalai, Okavango, Kwando/Linyati and Zambezi rivers.

Traditional pastoral farming practices in north-western Namibia involved the continual movement of stock from grazing area to grazing area, depending on the spatial distribution of annual rainfall. According to Fuller (1993), young men of the family unit moved the cattle and some small stock. The range that the stock were moved often required the young men to be absent from their villages for months at a time. Another strategy employed by pastoralists to cope with an arid environment was to divide the cattle herds into smaller units and farm these smaller herds out to relatives in different areas (not necessarily within the same area). This dispersal of herds was a way of spreading the risk in times of arid climatic cycles and thus increasing the chances that some of the herd might survive the arid period. Most small stock were traditionally kept nearer the village and not herded like cattle as they were not considered culturally as valuable and were used instead for food (Fuller, 1993).

During the 1970s, Kaokoveld experienced major infrastructural developments with the all weather roads, administrative offices, schools, hospitals and clinics being constructed. Numerous boreholes were drilled and semi-nomadic pastoral activities began to become sedentary, leading to a growth in livestock numbers.

This, in turn, led to the development of urban centres at Opuwo and Khorixas, providing western goods for sale that enticed communities in the Kaokoveld into a market economy and wage-labour system (Owen-Smith, 1996).

By 1991, nomadic pastoralism was practised on less than 15% of the land area of Namibia, due to rapid development and the growth of freehold farms. In practical terms, pastoralism was confined to the Nama communities in the south, the Herero and Tswana peoples in the east, and the Himba and Herero peoples of the north-west. In addition, pastoralism had been modified over the years by technology, the cash economy, western consumerism, local and migrant wage labour and socio-political philosophy (Owen-Smith and Jacobsohn, 1991). The changes to pastoralism from a semi-nomadic herding system to a more sedentary lifestyle have not always benefited either the people or the land. Increasing human population has also placed an added burden on the already scarce natural resources (Owen-Smith and Jacobsohn, 1991).

Today, pastoralism is still the most prevalent form of land use in north-western Namibia. It consists of small-scale, low-risk, low-input livestock husbandry. It yields a range of direct

use values, mostly from non-market and non-cash products, including milk, live animal sale/gifts, meat, draft-power, manure, and store value, as well as some cultural non-use values. These values include the 'prestige value' perceived by owners and society for livestock and in particular cattle ownership (McClure, 1998). For cultural reasons, the number of stock owned by a farmer is more important than the condition of the animals. Cattle in particular are required to pay bridal prices (lombola), gifts to sons on their birth, and for ceremonial purposes. Linked to this seems to be the general reluctance of farmers to de-stock the land in times of adverse climatic cycles. The general philosophy of farmers is that the more stock one has, the greater the likelihood that some will survive the arid period. Having stated this, many farmers in the north-west cannot afford large herds and so only keep small herds, for cultural, rather than commercial, purposes (Fuller, 2000). According to Barnes (1998), farmers need a minimum of 30 to produce a positive cash balance in the communal areas of Namibia. Few farmers in the north-west have herds of this size or larger.

Wildlife

Historical wildlife-population data is limited for north-western Namibia. There have been numerous anecdotal wildlife population numbers derived for the Kunene region, but few of these are based on scientific data. The oldest accounts of wildlife population and distribution of this century were reported by the German Colonial Office (1913) and by Fischer (1914). Shortridge (1934) and Bigalke (1958) conducted two of the better-researched early surveys. The publication of Shortridge (1934) was a compilation of older data and for this reason it was considered an important document. Police officers undertook the first official census of wildlife in 1955/56 (Joubert and Mostert, 1973), the results of which formed the basis for the publication of Bigalke (1958). While Bigalke's paper was a significant improvement on previous reports, it lacked distribution maps, the presentation of results was vague and was generally not considered to represent the true distribution of wildlife in Namibia (Joubert and Mostert, 1973). In addition, most of these earlier studies suffered from serious deficiencies, not the least of which were the authors' lack of knowledge of the total area they surveyed (Joubert and Mostert, 1973).

Game was known to be abundant in the Kaokoveld. Owen-Smith and Jacobsohn (1991) reported that until the 1970s, Kaokoveld supported large populations of big game including elephant, black rhinoceros, giraffe, Burchell's and Hartmann's mountain zebra and numerous species of antelope, as well as lion, leopard, cheetah, wild dog, hyena and several smaller predators.

The 1970s saw an increase in the number of civil servants and contractors in the region, which led to increased illegal hunting and trading in ivory, rhino horn and skins of leopard, cheetah and zebra. This period also saw the opening of the western front in the (then) South West African liberation war, which militarised the north-west, resulting in a proliferation of firearms. This coincided with an arid climatic period between 1979 and 1981 that decimated the wildlife and domestic stock populations. By the time the arid climatic period was over, the Kaokoveld's traditional pastoralist economy had been all but destroyed. In order to obtain cash to rebuild their herds and flocks many people turned to commercial poaching (Owen-Smith, 1996).

Since the early 1980s, the north-west of the Kunene Region has been the focus of conservation efforts, necessitated primarily by large-scale illegal hunting and the problem of declining numbers of wildlife.

Following community consultations by the Ministry of Environment and Tourism (MET) and NGOs, community support for conservation was mobilised. This, combined with effective law enforcement (MET with support from NGOs), resulted in wildlife numbers stabilising and then increasing once more.

Increasing wildlife numbers, combined with a demand for land from the people of the area, has resulted in an increased conflict between man and wildlife over scarce natural resources. With the view to addressing conflict, the Namibian government has taken steps to address wildlife management in communal areas through amendments to the conservation laws and the adoption of the communal area conservancy legislation (adopted 1996). This in effect gives communal farmers the right to manage and benefit from wildlife if certain conditions are undertaken. Farmers wanting to work together need to establish a representative body - the conservancy committee - with a constitution and a defined boundary with neighbours in order to gain these user rights. This body can then be gazetted and registered as a conservancy which then has legal status. These developments have significantly changed the perception of many local communities to problem animals, shifting the focus to the identification of locally applicable management solutions.

These initiatives have contributed to a situation where there is an abundant wildlife resource in north-western Namibia. An opportunity now exists for conservancies to benefit from the wildlife resource by sustainable use practices.

INTRODUCTION

Hoanib River Catchment Study (HRCS) Area

The Hoanib River catchment is one of twelve major ephemeral river catchments that occupy the semi-arid areas of north-western Namibia. All twelve rivers flow into the Atlantic Ocean or end in the Namib Sand Sea. The Hoanib originates in the western edge of the Etosha National Park, flows through commercial and communal farming areas and, near its mouth, traverses the protected Skeleton Coast Park. The Hoanib River catchment occupies an area of 17 200 km², 3% of which lies in private farm lands, 91% in communal farm lands, and 6% is protected in the Etosha National Park and Skeleton Coast Park (Jacobson *et al.*, 1995; Leggett, 1998).

The Hoanib River constitutes the boundary between the former Damaraland and Kaokoland. Since Independence (1990), these two areas have been incorporated into the Kunene and Erongo Regions (see Fig. 1). The Hoanib River catchment can be divided into three broad geographic (and vegetation) sections. The eastern section (east of the Khowarib Schlucht) is relatively densely vegetated with mopane woodland being dominant. The middle section of the Hoanib River (from the Khowarib Schlucht to the Skeleton Coast Park's eastern boundary) is sparsely vegetated. In the western section of the river (from the Skeleton Coast Park boundary to the coast), virtually no vegetation exists outside the river course. A broad flood plain (some 70km²), which is in front of the coastal dunes, offers substantial grazing for wildlife after flood events during the wet season (Jacobson *et al.*, 1995; Leggett, 1998).

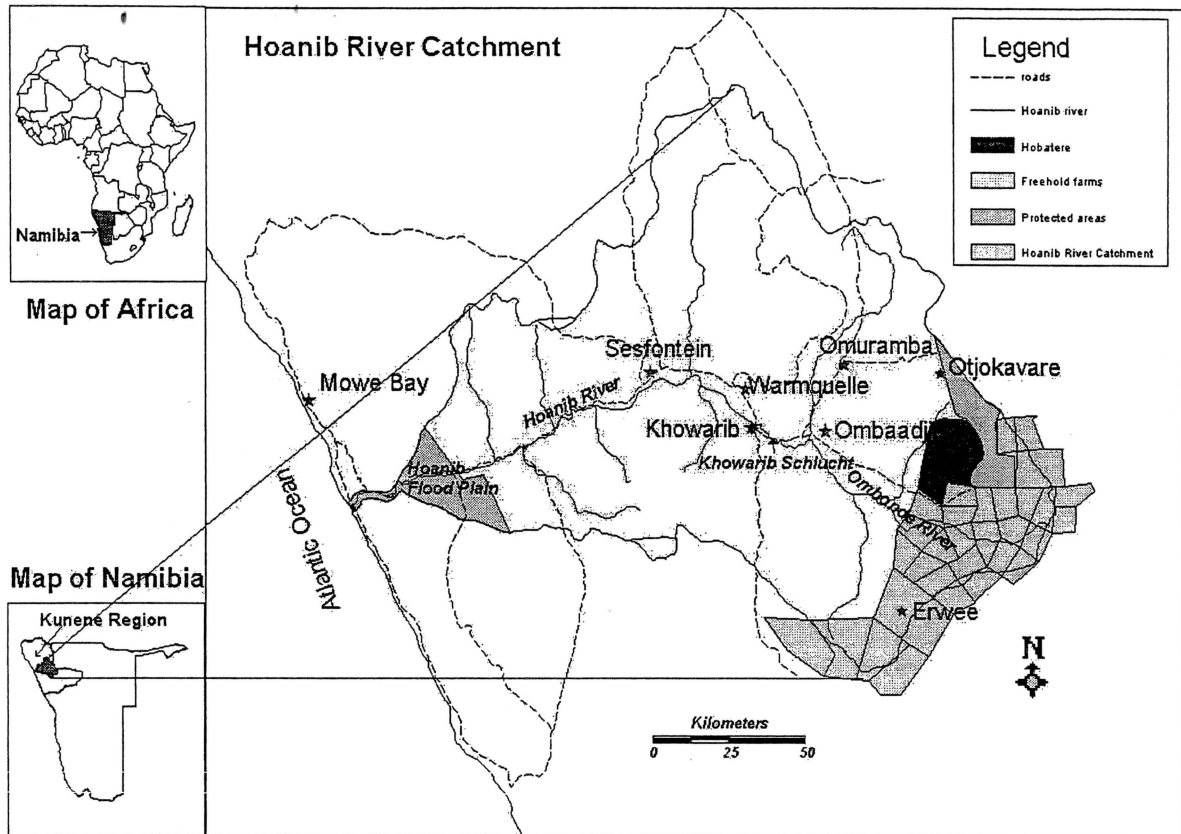


Figure 1: Location of the Hoanib River catchment

The Hoanib River forms a 'linear oasis' where the wetlands in the river form important biological and socio-economic areas in the catchment. They provide surface water for both domestic stock and wildlife, as well as a readily available source of water for communities living in the area. The water is being increasingly used in garden and irrigation projects, as well as for the expanding tourism industry. The biophysical nature of wetlands and other water sources varies over time and is dependent on rainfall and water extraction.

METHODS

DOMESTIC STOCK AND WILDLIFE SURVEYS

Aerial surveys

Three aerial surveys were conducted in April 1999, November 1999 and April 2000 over the entire Hoanib River catchment. Two additional surveys of Hobatere Game Park were conducted with MET and Hobatere management in April 1999. For a more detailed description of the methods used in the aerial surveying see Pennycrick *et al.* (1972), Norton-Griffiths (1978), and Gibson (1989). Aerial surveys varied between 16 and 18 hours flying time and the area from the Hoarusib River to approximately 15km upstream of Purros and areas to the north of the Uniab catchment were covered. The areas were surveyed along predetermined flight paths (see Figure 2 for detailed aerial survey blocks), covering major river courses, water holes and searching known wildlife areas. Additionally, 20 randomly chosen 3km x 3km grid squares were flown in areas where wildlife was not known to inhabit in order to obtain background counts. The combined survey area represents an estimated 4% coverage of the catchment. When wildlife were located, their positions were marked using a Global Positioning System (GPS) instrument and recorded manually (For flight details of all the aerial surveys, see Appendix A).

In all the surveys a minimum of two observers familiar with the terrain and one recorder accompanied the pilot. The plane flew at an altitude of between 100-150 m above ground level, depending on wind conditions and topography. Whenever possible, the surveys were conducted in the morning or evenings to take advantage of maximum visibility conditions. In addition, morning and evening flying corresponded to the periods when animals were most active and not under trees escaping the heat of the day.

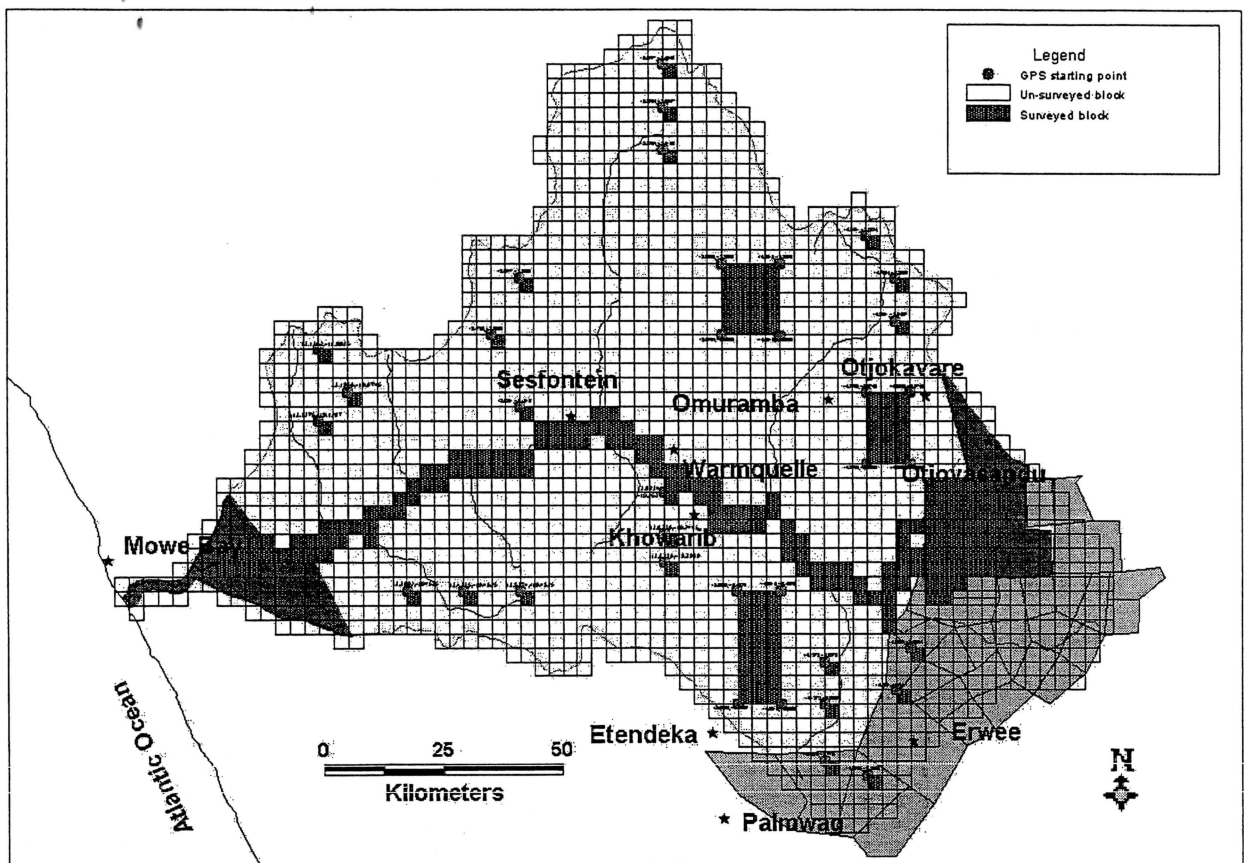


Figure 2: Aerial survey blocks in the Hoanib River catchment (1999-2000)

Hobaterre Game Park was used as a case study for animal movement, within the Hoanib River catchment. The game park was regularly surveyed by HRCS researchers in conjunction with MET and Hobaterre management. Aerial transects were flown at 1km apart, covering the entire area of the Game Park.

Ground surveys

Every two months the researchers undertook systematic ground surveys (from January 1999 until November 2000), driving the length of the Hoanib River on fixed transit routes (see Figure 3 for details of transect route). Transects were driven without break. However, it occasionally took more than one day to complete a transect in both the eastern or western sections of the catchment. The objective for driving these transects was to establish the distributions of economically important wildlife species and domestic stock within the catchment.

The species studied included:

- (a) cattle
- (b) goats
- (c) sheep
- (d) horses
- (e) donkeys
- (f) springbok (*Antidorcus marsupialis*)
- (g) gemsbok (*Oryx gazella*)
- (h) elephant (*Loxodonta africana*)
- (i) giraffe (*Giraffa camelopardis*)
- (j) mountain zebra (*Equus zebra hartmannae*)

During this study, no attempt was made to establish total numbers of these species in the catchment, even though the numbers of animals observed during these transects were recorded. The total estimates of the numbers of animals in the Hoanib River catchment quoted during this report were obtained from the MET 1998 and 2000 aerial surveys. All information was collated and stored on a wildlife specific database designed on a Microsoft Access programme.

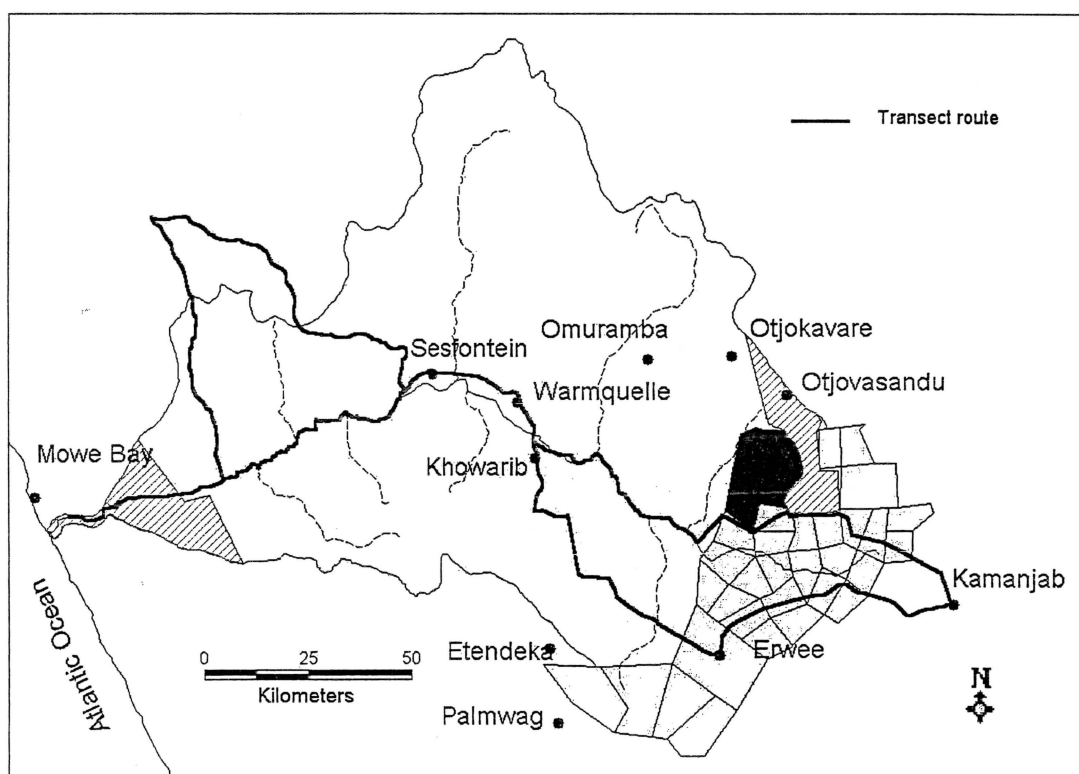


Figure 3: Ground survey transect routes conducted through the Hoanib River catchment.

Additional data collection

In addition to the data collected by HRCS researchers, the HRC community researchers in each of the six focus communities undertook additional surveys that have been incorporated into the results. The HRCS researchers provided the community researchers with basic training in how to identify and sex wildlife and domestic stock in their areas (see Appendix B for recording sheets).

Approximately once a month, over a one-year period (1999-2000), the community researchers undertook foot patrols within their village and the surrounding areas. These surveys were conducted in an attempt to establish densities of domestic stock and incidental recordings of wildlife and domestic stock, as well as to introduce basic scientific research methods into conservancy management practices.

Incidental car patrols were undertaken on occasion with employees of both Integrated Rural Development and Nature Conservation (IRDNC) and Save the Rhino Trust (SRT). Community researchers assisted with these patrols and, in turn, helped to forge a stronger working relationship between the NGOs.

Presentation of results

The domestic stock and wildlife distribution results presented have been divided into seasonal data. There are three recognisable seasons (Viljoen, 1988):

- (a) the wet season, from January to April
- (b) the cold dry season, from May to August
- (c) the hot dry season, from September to December

In practice, these seasons are flexible, especially when considering the 1999/2000 wet season, which commenced in October. However, these seasonal definitions are functional and broadly define season types. In addition, they have been used by previous researchers in the area and thus assist in the comparison of data.

RESULTS

Historical domestic stock data

In addition to the domestic stock data obtained from aerial surveys, data was obtained from the Department of Veterinary Affairs, Ministry of Agriculture, Water and Rural Affairs (1998) and McClure (1998). This data is presented in Figures 4 to 8.

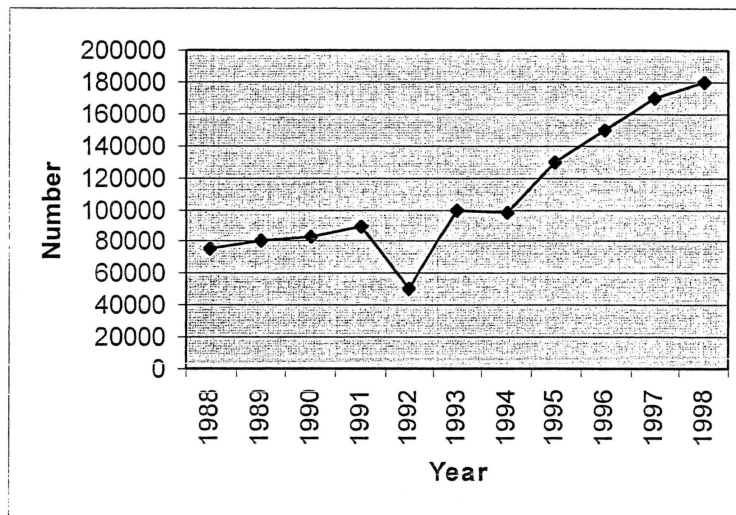


Figure 4: Cattle numbers in the Kaokoland, 1988-1998

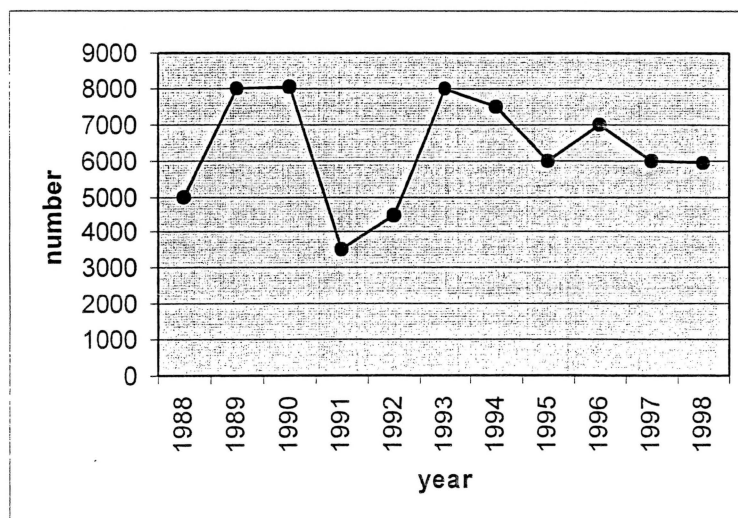


Figure 5: Donkey numbers in Kaokoland, 1988-1998

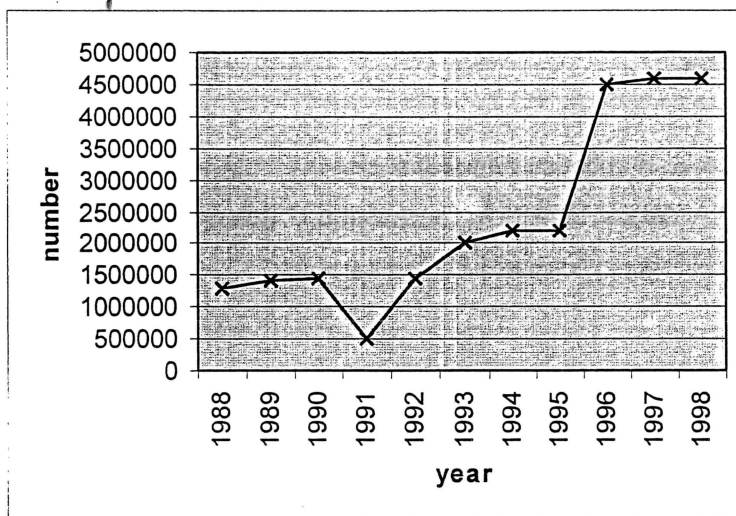


Figure 6: Goat numbers in Kaokoland, 1988-1998

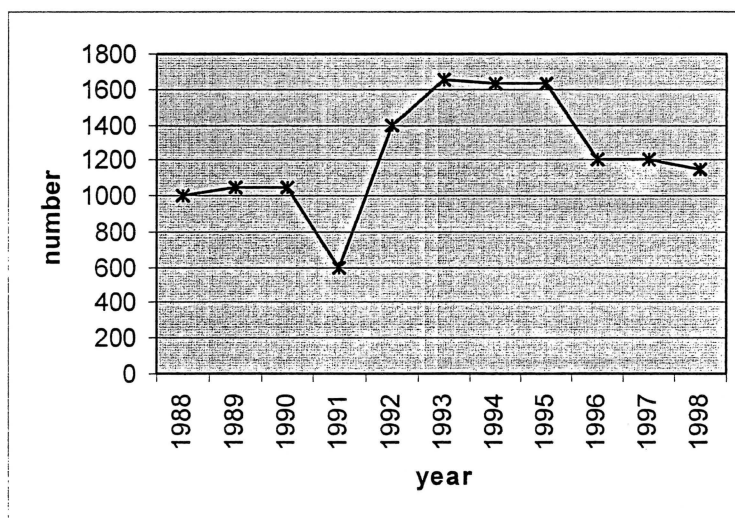


Figure 7: Horse numbers in Kaokoland, 1988-1998

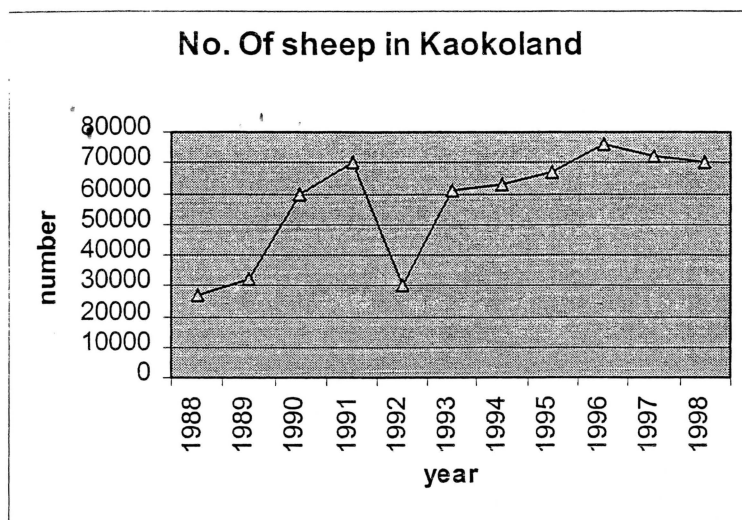


Figure 8: Sheep numbers in Kaokoland, 1988-1998

As can be seen in Figures 4 to 8, the numbers of domestic stock in the Kunene Region have been steadily increasing since 1988. The exception to this was 1991 when all domestic stock populations decreased. This population decrease was thought to be due to a dry period (Leggett *et al.*, 2001). There appears to have been some off-take of horses and donkeys since 1994 as numbers have remained relatively stable over this period. These animals would have most probably been sold, bartered or slaughtered for food.

AERIAL SURVEY DATA

Table 1 combines historical data from different aerial surveys in the Kunene Region. Early aerial surveys concentrated on sections of the Kunene region (either Damaraland or Kaokoland) with partial counts being undertaken in 1982, 1985 and 1986 (Carter 1990). It was not until 1990 that Carter (1990) undertook the first continuous survey of the area. Carter (1990) compared the data he obtained during his survey with the 1982 survey, as this survey was flown at different times of the year, but covered Kaokoland and Damaraland. Since this time the MET has conducted a number of aerial wildlife surveys i.e. in 1995, 1998 and 2000 (Loutit, 1995; MET, 1998 and 2000).

The areas covered during the 1982, 1990, 1995 and 1998 aerial surveys excluded most of central northern Kunene around Opuwo. The assumption that there were only small numbers of wildlife and large domestic stock populations in this region justified the exclusion of the central northern area.

This has led to the domestic stock figures being biased and the results below should only serve as an estimate to numbers. The 2000 aerial survey was conducted over the entire Kunene region.

Table 1: Wildlife and domestic stock estimated numbers in the Kunene Region, 1982-2000

Species	Aerial Survey					
	1982 ¹ Koakoland and Damaraland	1986 ² Damarland	1990 ³ Kunene Region	1995 ⁴ Kunene Region	1998 ⁵ Kunene Region	2000 ⁶ Kunene Region
Domestic Stock						
Cattle				13744	108559	175772
Donkey				636	4144	6404
Goats/sheep				30577	183569	273350
Horse				265	2604	2250
Wildlife						
Burchells zebra				28		
Elephant	220	247	265	415	579	794
Gemsbok	543	928	1624	1103	11850	17425
Giraffe	277	308	264	267	548	1105
Hartmanns Zebra	738	1288	2316	1488	6413	13352
Kudu		124		273	901	934
Ostrich	509	1286	1388	804	4385	7179
Rhino		28		16		
Springbok	497	2632	6245	1791	22981	26654

¹ Viljoen (1982); ² DNCT (1986); ³ Carter (1990); ⁴ Loutit (1995); ⁵ MET (1998); ⁶ MET (2000)

The data from Table 1 indicates that wildlife populations have been steadily increasing in the Kunene since the early 1980s.

Table 2 presents the results of the aerial surveys conducted in Hobatere Game Park in 1999 and 2000.

SEASONAL AND PERMANENT WATER SOURCES

Seasonal and permanent springs and wetlands in the Hoanib River catchment area are presented diagrammatically in Figure 9.

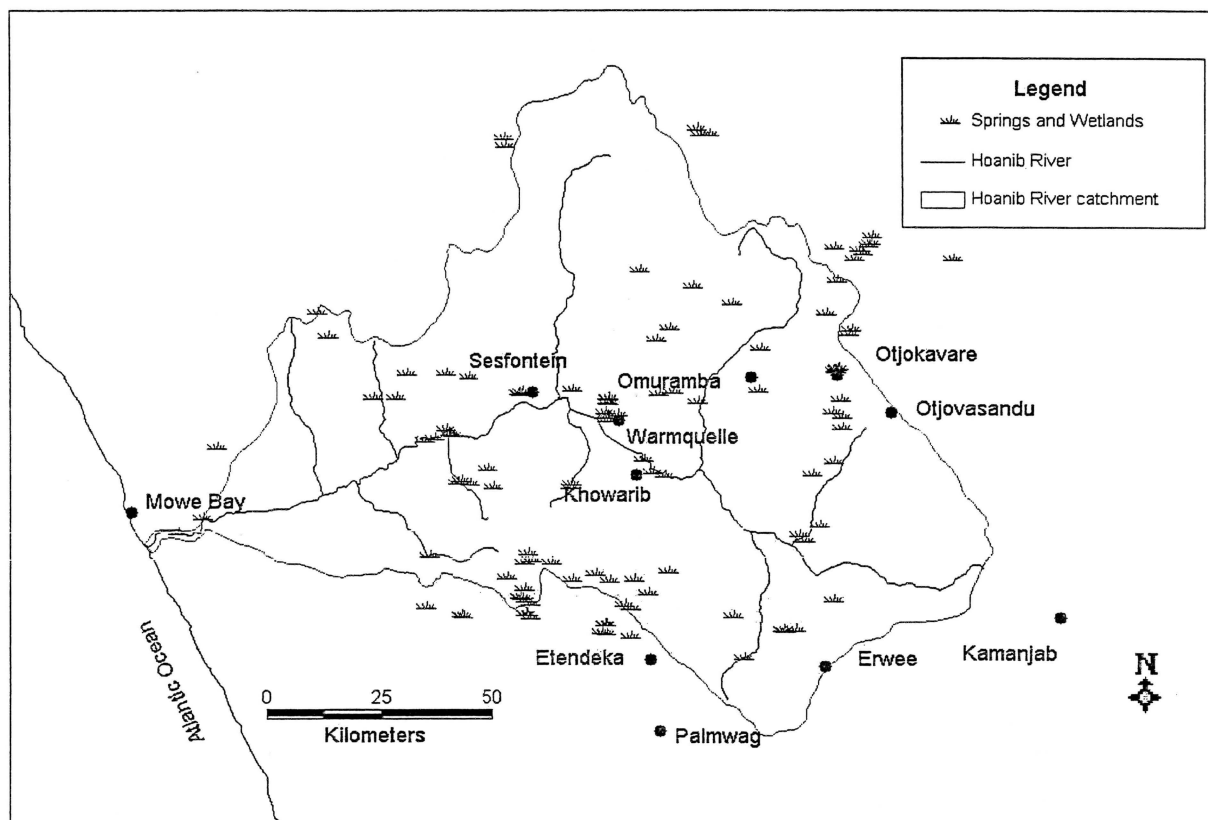


Figure 9: Seasonal and permanent springs and wetlands in the Hoanib River catchment

The boreholes in the Hoanib River catchment are presented diagrammatically in Figure 10.

Table 2: Aerial survey results of Hobatere Game Park, 1999-2000

Species	Aerial Survey			
	4 th April 1999	8 th April 1999	11 th November 1999	16 th April 2000
Domestic Stock				
Cattle	NO	NO	28	NO
Donkeys	NO	NO	NO	7
Wildlife				
Baboon	NO	10	5	7
Eland	97	144	10	127
Elephant	11	24	8	10
Gemsbok	112	506	35	186
Giraffe	73	121	24	109
Hartmanns Zebra	523	1137	121	531
Kudu	61	50	12	15
Ostrich	5	9	4	8
Springbok	148	152	18	55
Warthog	5	NO	NO	4

NO – Not observed

The data in Table 2 indicates that aerial surveying is not a precise technique, as shown by the significant variation in two species (gemsbok and Hartmanns zebra) in the observations in surveys done four days apart. The surveys were conducted to test the method for reproducibility and precision and the same observers were used for both surveys with the major difference being the east/west orientation of the flight rather than north/south. While the aerial survey method was thought to be inaccurate for determining absolute numbers of animals present, it does give a general trend that is useful in interpreting wildlife movement. The April surveys (1999 and 2000) were conducted at the end of the wet season when populations of wildlife in Hobatere appeared to be most populous. In contrast, the November 1999 survey was flown the day after the first rains (Leggett *et al.*, 2001) in the catchment and does indicate a clear decrease in number of animals observed at this time.

Domestic stock

Seasonal cattle distribution

For a schematic representation of the seasonal distribution of cattle see Figure 11.

Cattle distribution appeared to be closely linked to human settlements and water sources. Even during the wet season when water was most abundant in the veld, cattle populations appeared to be concentrated around permanent and seasonal settlements. There appeared to be a wet season herding of cattle into areas where seasonal grazing and water were available (southern section of the Khowarib and Serengeti plains). The daily range of cattle during the wet season tended to be rather small and they drank once or twice a day (HRC Community Researchers pers.com, 2000). Towards the cold dry and hot dry season, the daily range of the cattle expanded to a maximum of approximately 15km from a water source and the cattle tended to drink once a day (HRC Community Researchers pers.com, 2000; B. Kruger, pers.com, 2001). There also appeared to be a net movement of cattle out of the catchment during this period, as the numbers of animals observed at this time were relatively low compared to the wet and cold-dry season. Like all domestic stock, cattle are dependent on water and cannot live in areas without an assured water supply.

During this study, the majority of domestic stock observations were made within a 15km radius of settlements, namely:

- Omuramba, Ombaadjie and Kovare (Beesvlakte)
- Otjokavare (north from Hobatere)
- Khowarib (south and central plain)
- Otjizeka (Serengeti plains, eastern section)
- Warmquelle (north-eastern Khowarib plains)
- Sesfontein/Otjondakui (Sesfontein plains)
- Annabeb/Otjuntunda (north-western Khowarib plains)

In the 1997-1998 season, 5000 cattle were observed in the eastern section of the Serengeti plains, from Otjizeka to Palmfontein (R. Loutit, pers. comm, 1998). However, during the course of this study approximately 800 head were observed in the same area. The majority of cattle that were grazing here during the 1997-1998 season were reportedly from areas outside of the catchment (Herder pers.com, 1998).

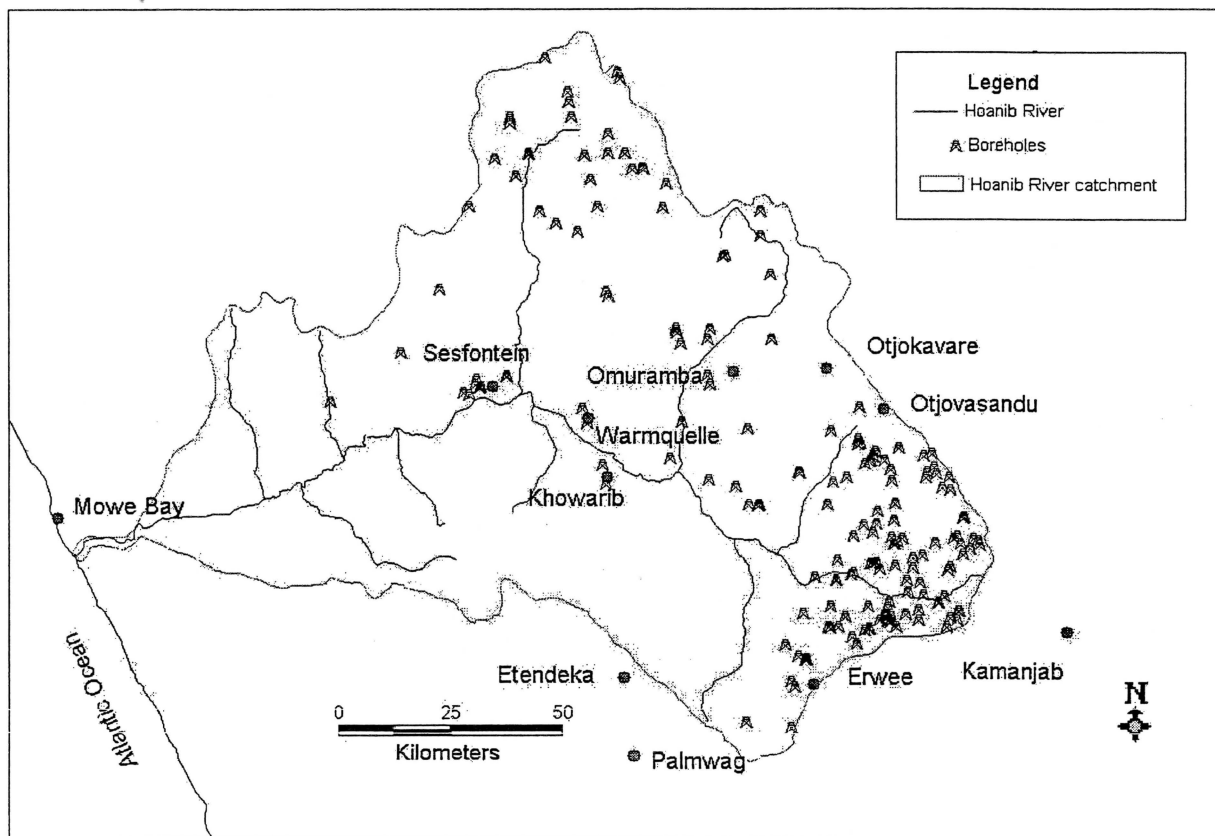


Figure 10: Boreholes in the Hoanib River catchment

SEASONAL DOMESTIC STOCK AND WILDLIFE DISTRIBUTIONS IN THE HOANIB RIVER CATCHMENT

The distribution maps (depicted in Figures 11 to 20) for wildlife and domestic stock are the compilation of data collected during the aerial surveys, the driven ground transect surveys and ground observations made by the community and HRCS staff researchers. The distribution data presented here does not represent the total animal numbers in an area, but rather group numbers observed during each survey. The data presented here represents the relative seasonal distributions of the locations of animals in the wet, cold-dry and hot-dry seasons.

In community meetings conducted by HRCS researchers (February, 2001) the pastoralists of Omuramba and Otjokavare described this area as a 'hard times' grazing area, so-called because this area was only used in times of aridity when no other grazing was available in the areas more appropriate for pastoralism.

Seasonal donkey distribution

For a schematic representation of the seasonal distribution of donkeys in the Hoanib River catchment, see Figure 12.

The distribution of donkeys was closely associated with human populations and assured water sources. There also appeared to be a dry season aggregation, but this was probably closely linked to the distribution of human settlements during the hot dry season rather than the availability of water and grazing.

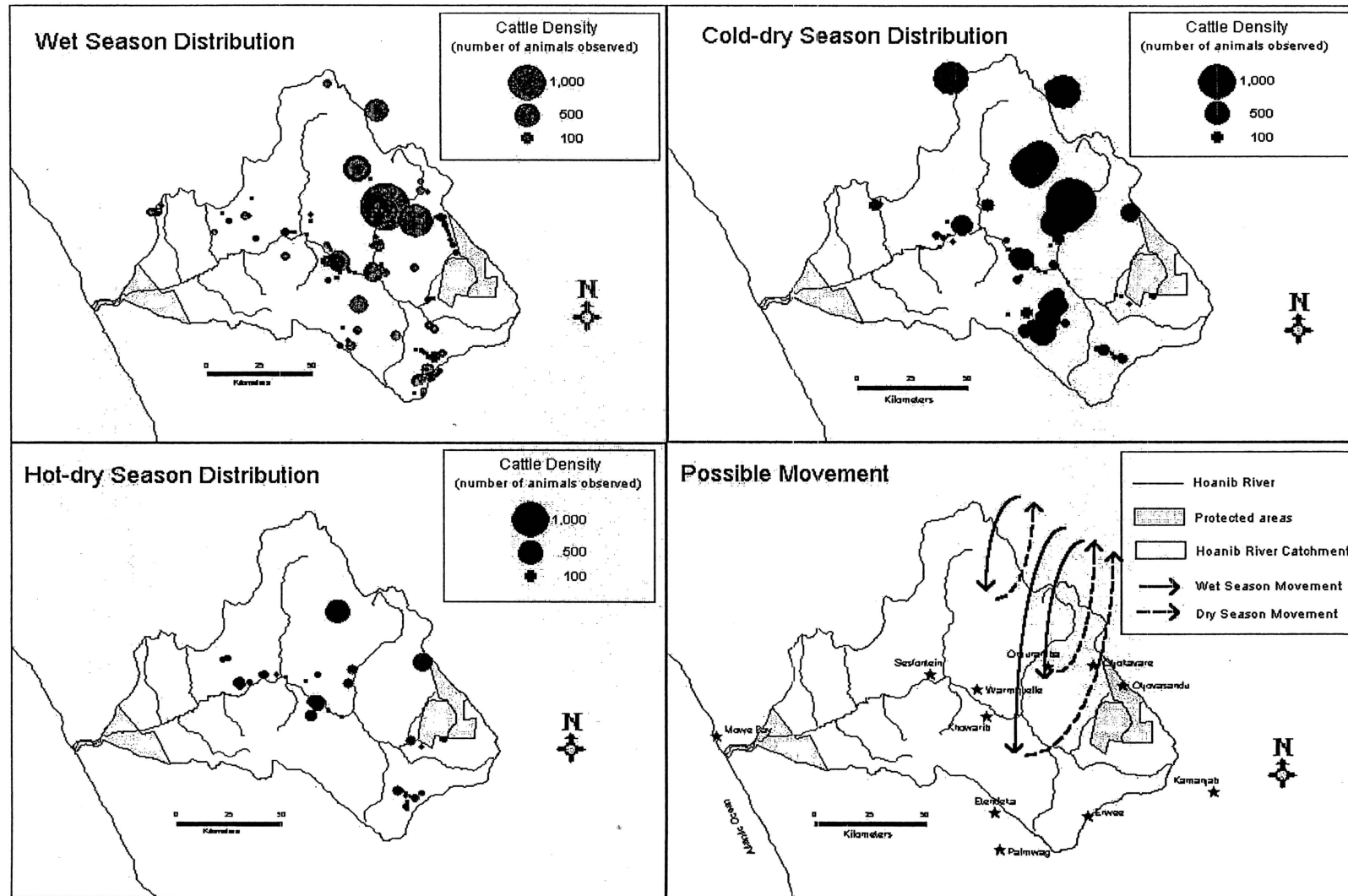


Figure 11: Seasonal distribution of cattle in the Hoanib River catchment, 1999-2000

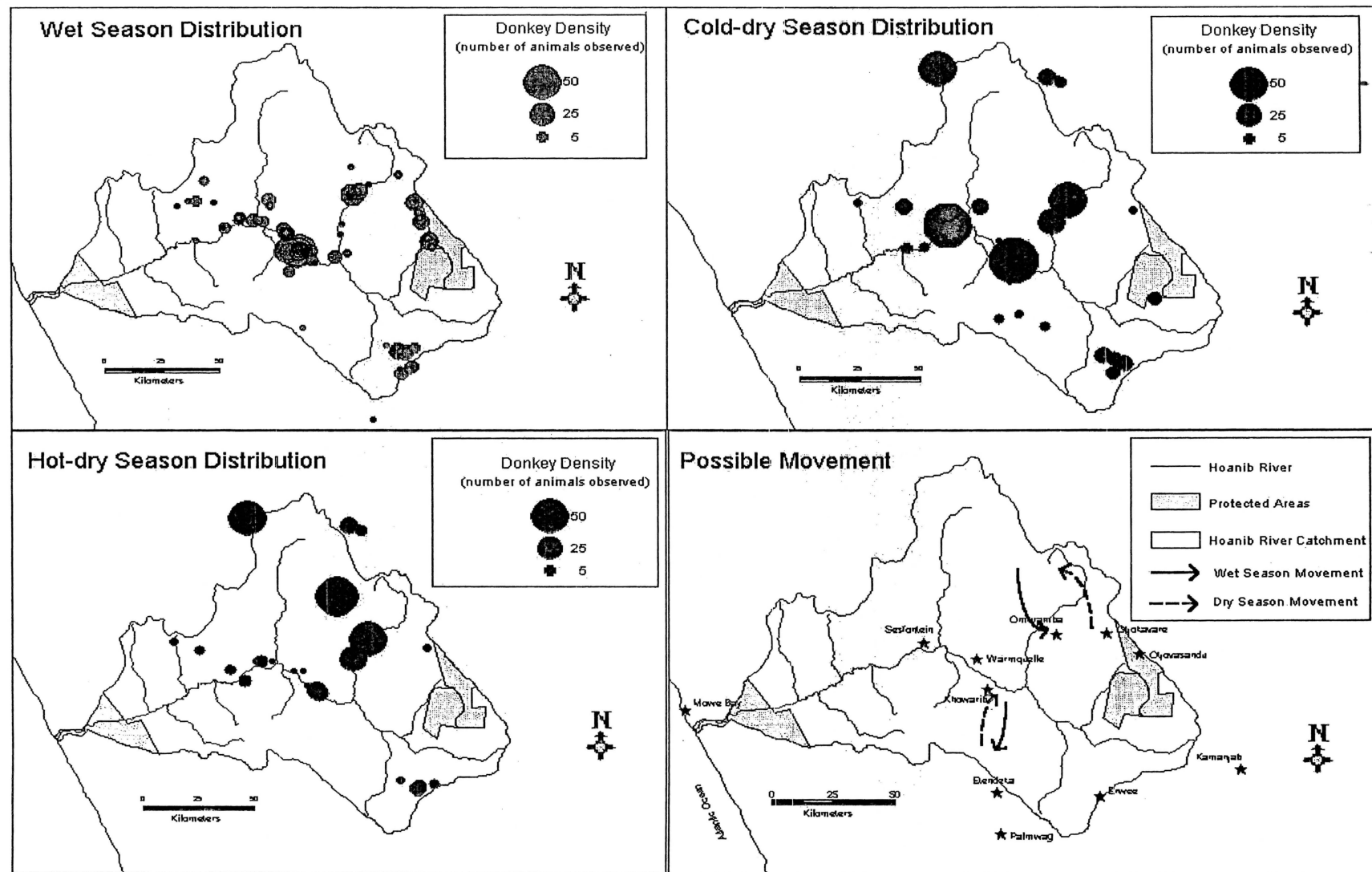


Figure 12: Seasonal distribution of donkeys in the Hoanib River Catchment, 1999-2000

Seasonal goat distribution

For a schematic representation of the seasonal distribution of goats in Hoanib River catchment see Figure 13.

Goat distribution in the Hoanib River catchment was closely linked to human population and assured water sources. The wet season range of goats was more dispersed with the goats being herded to seasonal grazing areas along with cattle. The herd sizes also appeared to be larger at this time. The daily ranges of goats during the wet season appeared to be relatively small, but this was dependent on the distribution of available grazing. During the cold dry and hot dry season, when seasonal water sources had begun to dry out, goats were herded to areas around the permanent water sources (a similar movement pattern to that observed for cattle). As grazing around permanent water points became scarce, daily feeding ranges appeared to increase to 5-7km from a water source (HRC Community Researchers, pers.com, 2000; B. Kruger, pers.com, 2001). The herd sizes of goats also appeared to decrease during this time. Goats occupied the same range area as cattle and their population densities centred on the same settlements.

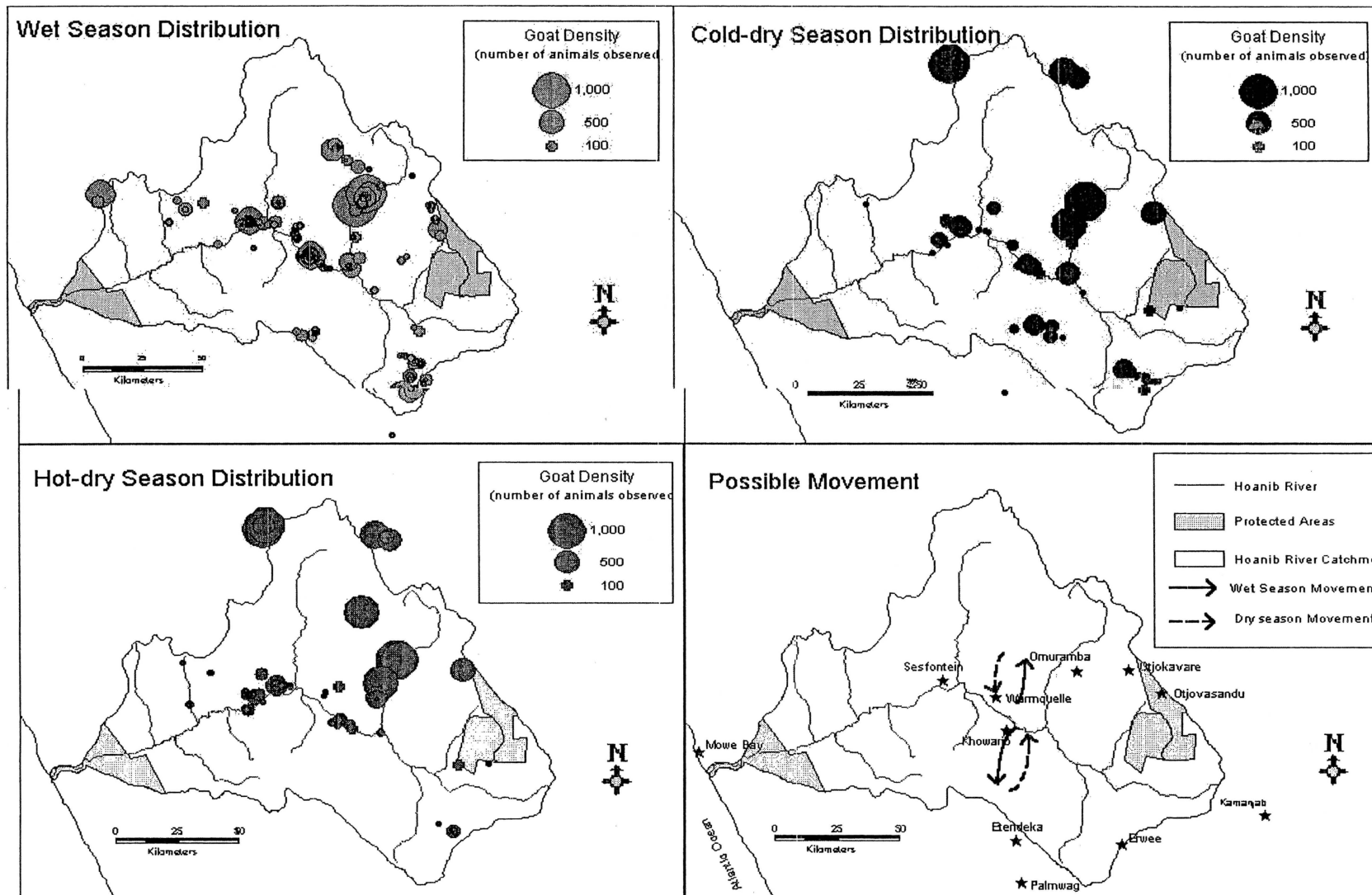


Figure 13: Seasonal distribution of goats in the Hoanib River catchment, 1999-2000

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Seasonal horse distribution

For a schematic representation of seasonal distribution horses in the Hoanib River catchment see Figure 14.

There were relatively few horses observed in the catchment and most were recorded in the eastern section. They appeared to be closely associated with humans and follow a similar distribution to donkeys.

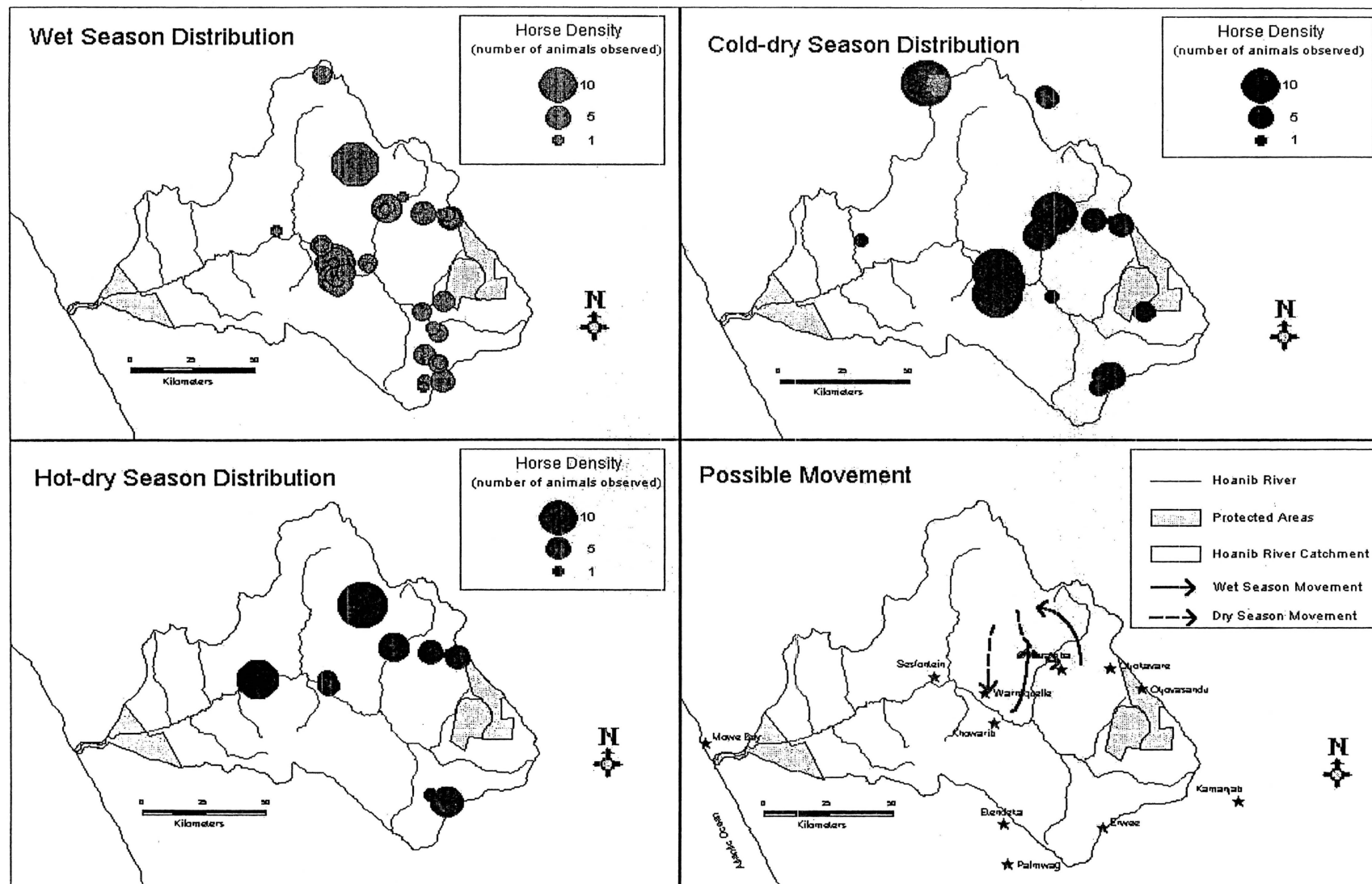


Figure 14: Seasonal distribution of horses in the Hoanib River catchment, 1999-2000

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Seasonal sheep distribution

For a schematic representation of seasonal distribution of sheep in the Hoanib River catchment see Figure 15.

Sheep and goats occupied the same range areas and veld conditions. They are closely associated to humans and water sources, they have limited grazing ranges and these ranges are strongly linked to seasonal rainfalls.

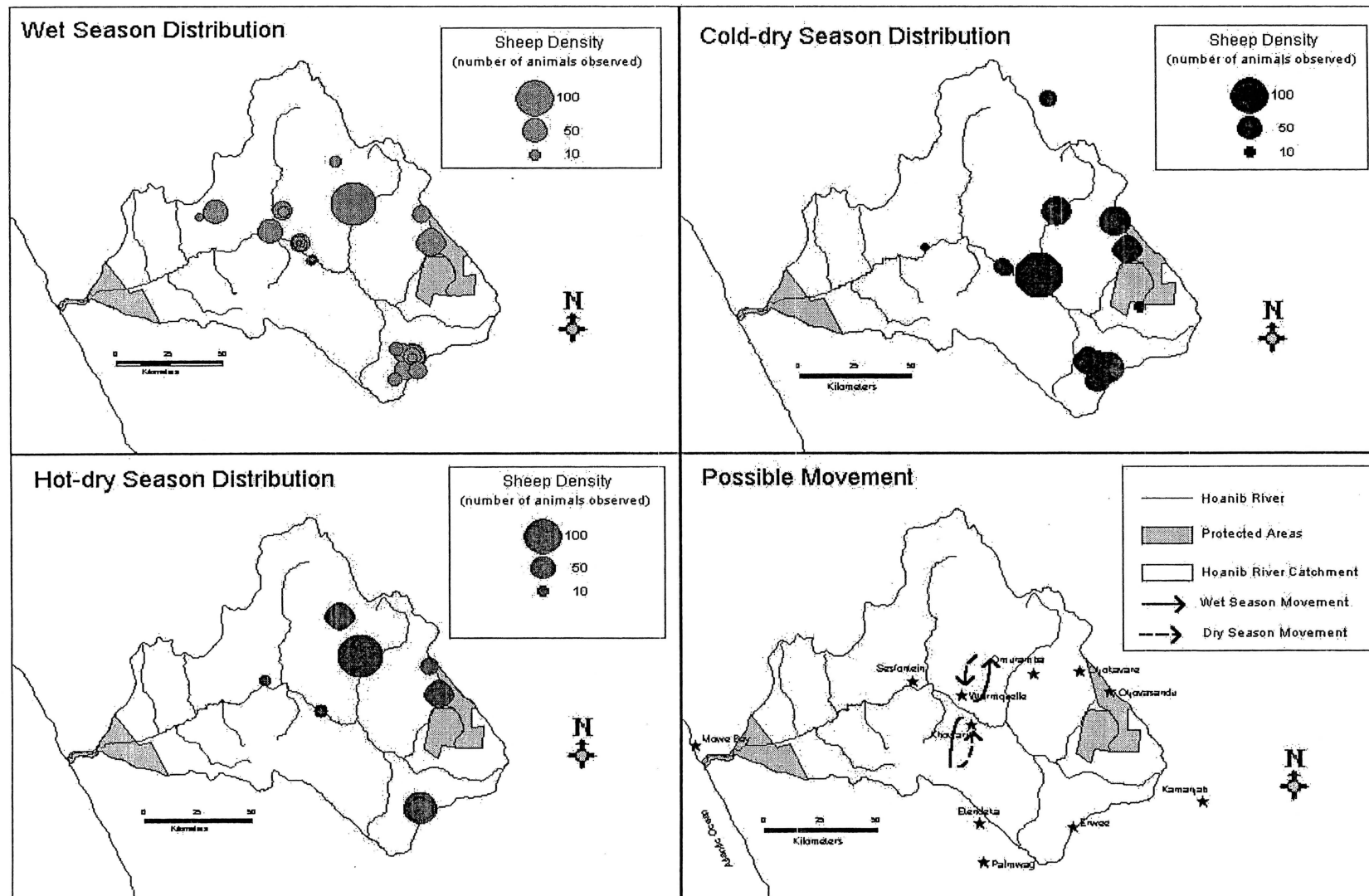


Figure 15: Seasonal distribution of sheep in the Hoanib River catchment, 1999-2000

Wildlife distributions

Seasonal elephant distribution

For a schematic representation of the seasonal distribution of elephants in the Hoanib River catchment see Figure 16.

Elephants appeared to prefer areas where human population and domestic stock populations were low. The exception to this appeared to be around Omuramba where elephant density during the cold dry and hot dry seasons appeared to be relatively high. Elephant distribution appeared to be associated with the riverbeds (especially in the western catchment) where numbers increased during the hot dry season. There also appeared to be a wet season and early cold season increase in elephant numbers in the Hoanib flood plain, as well as in Hobatere. These seasonal distributions appeared to be linked to the browsing and grazing availability in each area. Elephants are a water-dependent species and while their home ranges are large, they must be able to access large amounts of fresh water regularly.

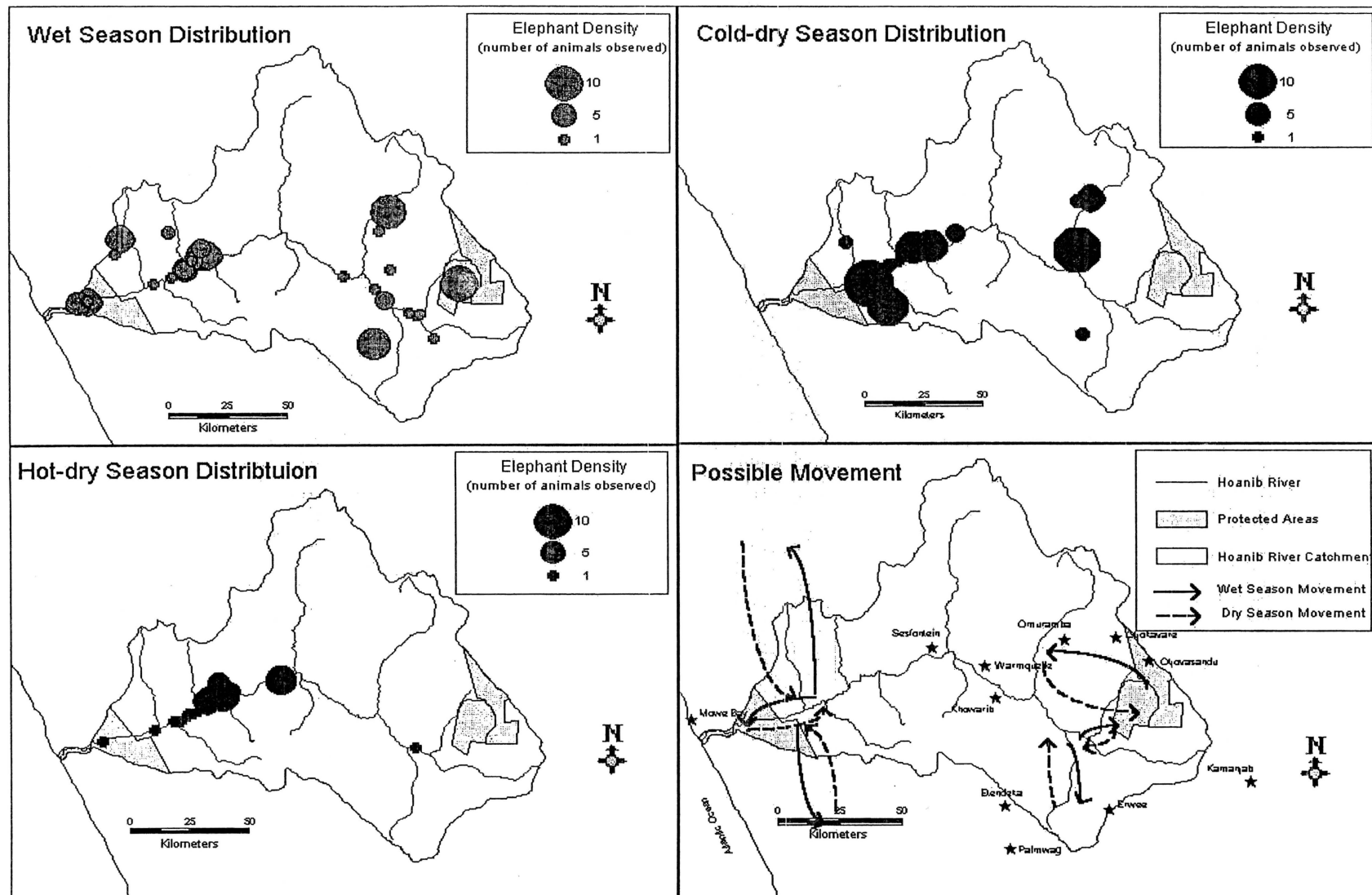


Figure 16: Seasonal distribution of elephant in the Hoanib River catchment, 1999-2000

Seasonal gemsbok distribution

For a schematic representation of the seasonal distribution of gemsbok in the Honaib River catchment see Figure 17.

Gemsbok distribution appeared to be limited to areas where human habitation and domestic stock populations were low. The main population of gemsbok appeared to be between Sesfontein and the coast, Hobatere and in the isolated southern areas of the catchment around the Etendeka Mountains. There also appeared to be a seasonal increase in numbers of gemsbok in the Hoanib flood plain after the annual floods and subsequent vegetation growth. Gemsbok are not a water-dependent species and therefore have extensive home ranges.

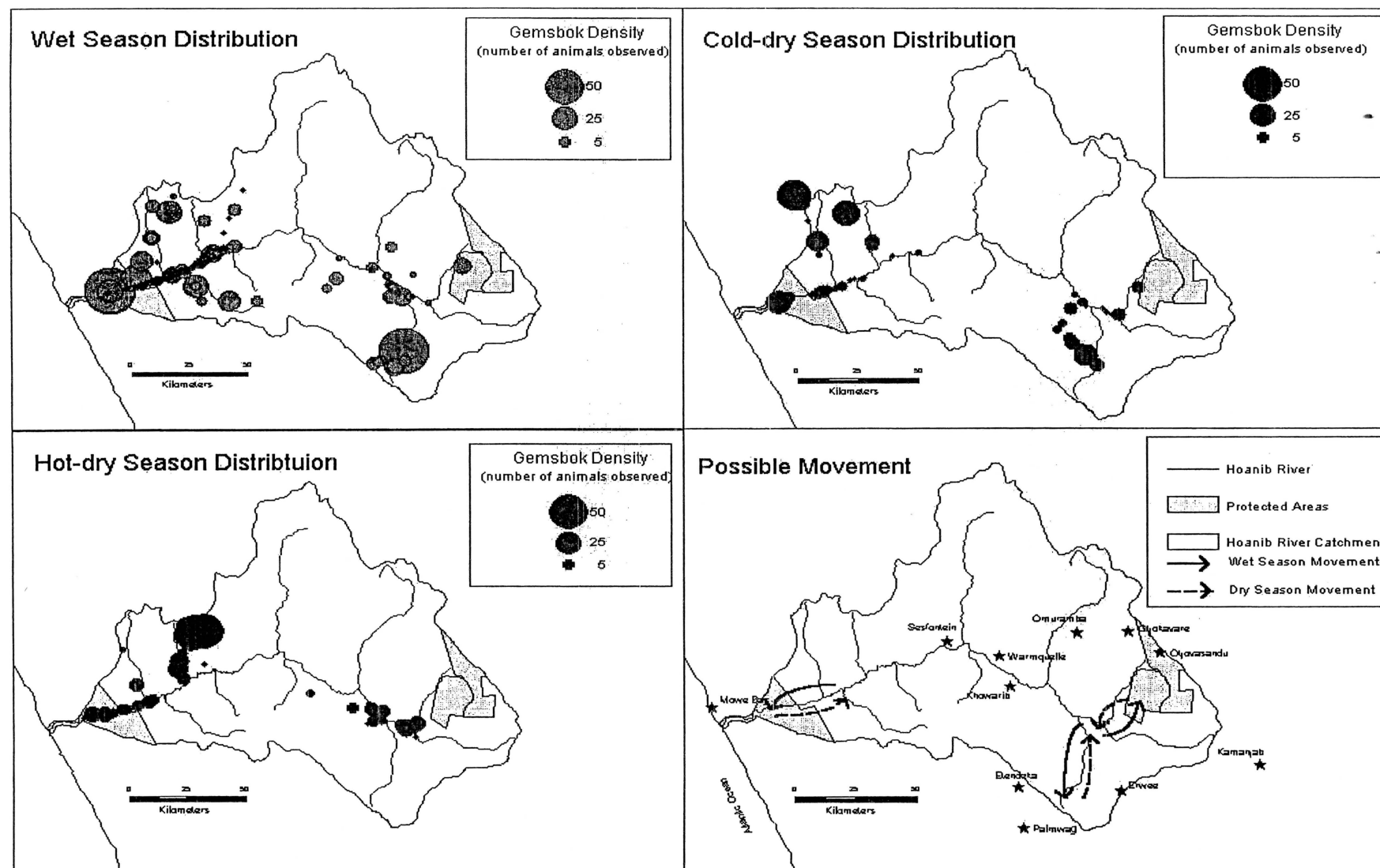


Figure 17: Seasonal distribution of gemsbok in the Hoanib River catchment, 1999-2000

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Seasonal giraffe distribution

For a schematic representation of the seasonal distribution of giraffe in the Hoanib River catchment see Figure 18.

Giraffe distribution was limited to those areas where human and domestic stock populations were low. In the western catchment, they appeared to be most abundant along the riverbed between Sesfontein and the coast. However, in the eastern section of the catchment they were most abundant along the Ombonde River, Hobatere and in the Etendeka Mountains. During the hot dry season, giraffe numbers appeared to increase in the riverbeds. A wet season increase in numbers appeared to occur in Hobatere and in the mountains to the north and south in the eastern catchment. Giraffe are not water-dependent, though their ranges in the western catchment appeared to be limited to the riverbed.

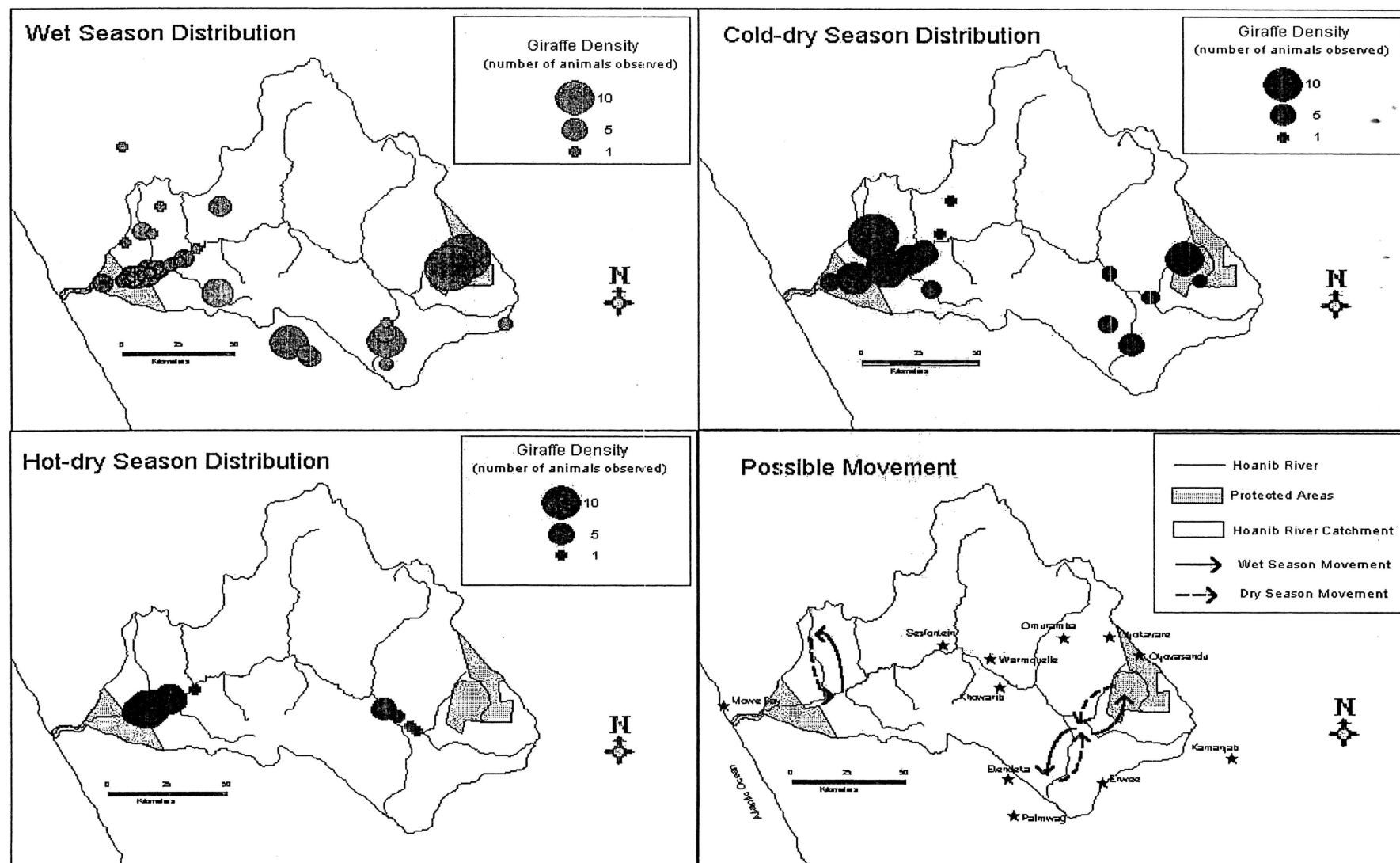


Figure 18: Seasonal distribution of giraffe in the Hoanib River catchment, 1999-2000

Wet season distribution of Hartmann's mountain zebra

For a schematic representation of wet season distribution of Hartmann's mountain zebra see Figure 19.

The wet season distribution of Hartmann's mountain zebra appeared to be in areas with low domestic stock and human populations. Only limited data was available for the cold dry and hot dry seasons but Hartmann's mountain zebra tend to keep a similar range throughout the year. They are a water-dependent species but have extensive ranges.

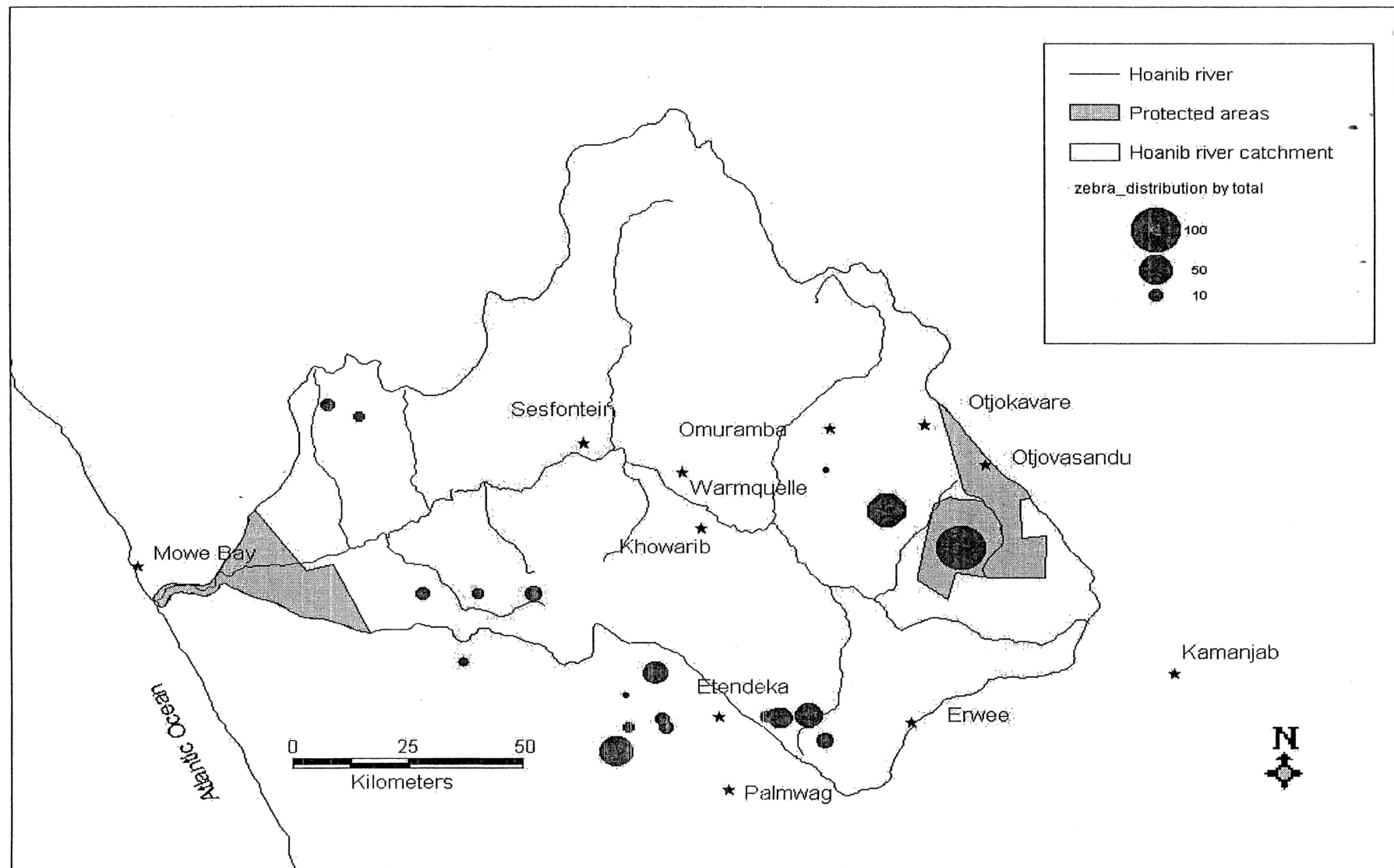


Figure 19: Wet season distribution of Hartmann's mountain zebra in the Hoanib River catchment, 1999-2000

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Seasonal springbok distribution

For a schematic representation of the seasonal distribution of springbok in the Hoanib River catchment distribution see Figure 20.

The majority of springbok were observed in the area between Sesfontein and the coast. There appeared to be localised concentrations of springbok in the Khowarib and Beesvlakte as well as between Omuramba and Ombaadjie. At the end of the wet season and into the cold dry season, large numbers of springbok were observed in the southern section of the catchment throughout the Etendeka Mountains. This appeared to have occurred in response to localised grazing availability. The range of the wet and cold dry seasons appeared to be far more extensive than the hot dry season range where the majority of springbok observations were concentrated in and around the riverbed. Although the range covered by springbok was extensive, they were regularly observed to occupy the same range as domestic stock. Springbok are not dependent on the availability of water in this environment.

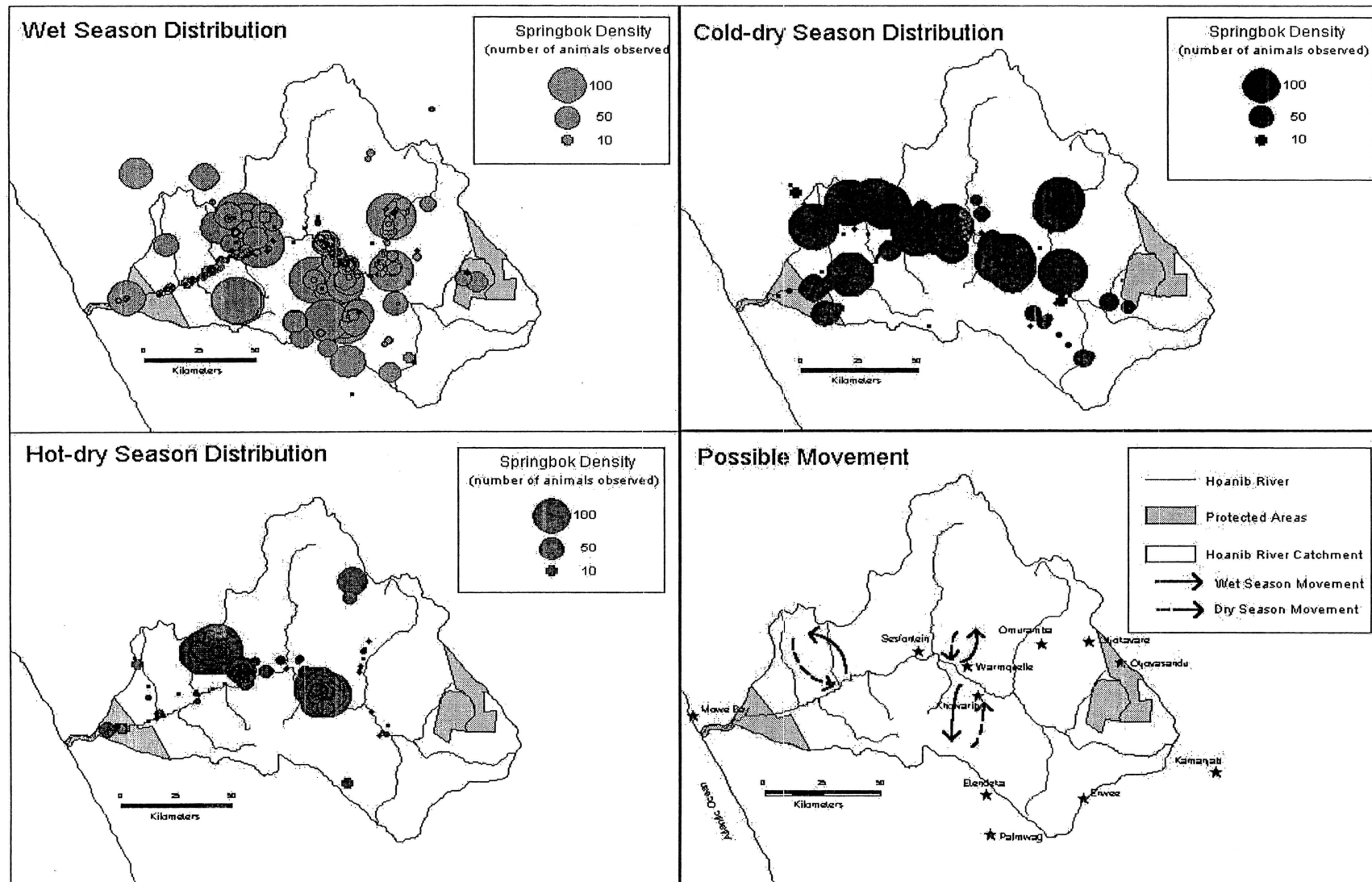


Figure 20: Seasonal distribution of springbok in the Hoanib River catchment, 1999-2000

DISCUSSION

DOMESTIC STOCK

From the historical data, it can be observed that the populations of domestic stock periodically fluctuate according to climatic cycles. During 'normal' wet seasons, when grazing is available, the population of domestic stock increases. However, during a dry period the numbers of domestic stock fall sharply (1991-1992). The last major dry period in the north-west was during 1981-1982, when approximately 90% of the domestic stock population died (Viljoen, 1982).

The distribution of domestic stock was assumed to be limited by the seasonal availability of grazing and water. However, there appeared to be little difference in the distribution of domestic stock throughout the wet, cold-dry and hot-dry seasons. There were two exceptions to this:

- (a) domestic stock moving to the area south of the Khowarib plains when seasonal grazing was available and then moving back to the permanent water sources during the hot dry season or when the grazing and water were depleted.
- (b) the Serengeti plains across to Palmfontein in the south-eastern corner of the catchment showed a similar distribution pattern.

When grazing was depleted close to the villages and around the permanent water sources, domestic stock had to trek further each day in order to find sufficient grazing, before returning to drink. According to Auer (1997), wildlife and domestic stock have similar daily movement ranges but for the most part, wildlife do not need to drink daily. In addition, the trek to and from water (daily or weekly) does not seem to affect their condition. However, domestic stock lose condition rapidly if they have to trek substantial distances to and from water each day.

As domestic stock need to drink every day, their maximum grazing range is determined by how far they need to trek to find grazing, graze and then return to drink. Small stock are thought to graze to a maximum of 5-7 km from a water source, while it is believed that cattle graze up to a maximum range of 15-18km from a water source. Free-ranging donkeys and horses have a greater feeding range than other domestic stock (up to 30km from a water point) (R. Loutit, pers. com. 1998).

- However, they tend to be closely associated with humans as they are used as beasts of burden i.e. for transport of goods and people, and tend to be in close proximity to humans and settlements. These distribution distances are similar to those reported by Verlinden *et al.* (1998), from the southern Kalahari in Botswana. Cattle range was reported to be up to 20km from a water source but more likely to be less than 12km. Sheep, goats and donkey range was reported to be less than 7km and in much closer association with a water point.

The seasonal ranges of domestic stock were heavily dependent on the spatial distribution of rainfall. The wet season ranges of domestic stock tend to be more dispersed, with the stock being herded to seasonal grazing, generally some distance from permanent settlements. During the cold-dry and hot-dry seasons when seasonal grazing and water became limited, the stock were herded back to the permanent villages and water sources.

The exception to this appeared to be cattle. It is thought that in the Hoanib River catchment they are still farmed along the traditional pastoral practices as reported by Fuller (1993). There appeared to be a general decline in cattle numbers across the catchment during the hot-dry season. This decline was thought to be due to one of two factors:

- (a) the pastoralists moved their herds to areas that were not routinely surveyed by researchers (community and HRCS), or they were moved completely out of the catchment
- (b) cattle were farmed out to relatives in areas outside the catchment as a strategy to avoid hot-dry season overgrazing and crowding around the permanent water sources.

It appeared more likely that the cattle were being farmed out to relatives in other areas as a strategy to minimise loss during the hot-dry season.

The exception to these traditional pastoral activities occurs during the dry period when grazing is limited over the entire north-western Kunene Region. Cattle are herded to areas that are not best suited for grazing and are termed 'hard times' grazing areas. In the Hoanib River catchment, the area located in the southern section of the eastern catchment (Serengeti plains to Palmfontein) was used by the pastoralists of Otjokavare and Omuramba as a 'hard times' grazing area. This section of the catchment has only limited water sources, coupled with a rugged terrain. Although there appeared to be grazing available most of the year (sometimes at a distance from the water points), the area was not frequently used by pastoralists during 'normal' years. The reason given by pastoralists for not using this area was that cattle lose condition rapidly when they have to trek long distances between water and grazing over rugged terrain. However, in arid years when there is no other grazing available at any other place in the catchment, this area is used. The 1997-1998 wet season provided

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less than average amounts of rain to most of the northwestern Kunene Region. This forced the pastoralists to herd their cattle into areas where they would not normally graze. It was believed that some of the cattle grazing in the south-eastern corner of the catchment during this period came from an area north of Opuwo (Local herder, pers.com.1998).

WILDLIFE

Despite the decline of wildlife in the Kunene Region throughout the 1970s and early 1980s as a result of poaching and a dry period, the densities of today's population now match those recorded in the 1960s. This increase has been achieved mainly through government initiatives, NGO support and, above all, increased community support for the emerging conservancy programme. Coupled with this has been a 'normal' climatic cycle that has allowed for population growth of wildlife.

Most species of wildlife in the Hoanib River catchment are not as susceptible to arid climatic cycles as domestic stock. However, during the last arid cycle in 1981-1982 approximately 80% of some wildlife population (zebra, kudu, springbok and gemsbok) were believed to have died (Viljoen, 1982).

During the wet season, wildlife appeared to be widely distributed throughout the catchment. After good general rains in 1999 and 2000 wet seasons, wildlife formed feeding aggregations in the following areas:

- (a) Southern Khowarib plains, approximately 10-20km south of Khowarib village: approximately 700 springbok, 100 ostrich, and 100 gemsbok.
- (b) Khowarib plains, approximately 5-7km west of Khowarib village: approximately 1000 springbok, 200 ostrich and 50 gemsbok.
- (c) Serengeti plains, approximately 20km north of Otjitheka spring: 4 elephants, 100 springbok and 7 giraffe.
- (d) Otjiyapa spring, approximately 7km north of Etendeka tourist camp: 5 elephant, approximately 1000 springbok, 300 zebra and 200 gemsbok.

Seasonal aggregations of wildlife are common in the western areas of the catchments as reported previously by Tarr and Tarr (1988). These authors studied the increase in annual and perennial grasses with an unusual rainfall event in the western section of the Hoanib River catchment during 1982-84.

In addition, Tarr and Tarr (1988) reported an east-west movement of wildlife during the wet season as they sought to take advantage of early rains in the east – which was also observed during this study for the wildlife in the western section of the catchment.

Wildlife continued feeding in these areas in large herds until the seasonal vegetation was exhausted, which tended to occur towards the middle of the cold-dry season. Towards the end of the cold-dry season, herd sizes were observed to decrease and the plains game drifted back to the rivers. Elephant populations were seen dispersing at the same time, with a number of herds moving north to the Hoarusib River. At this time, giraffe were also still widely dispersed, and formed into smaller herds.

This trend continued into the hot-dry season with wildlife concentrating in the riverbeds. Towards the end of the hot-dry season, several feeding aggregations of elephant and giraffe were observed in the riverbeds where the maturing seedpods of the *Faidherbia albida* provided a valuable source of protein at a time when there was little nutrition in the veld. *Faidherbia albida* occur in both the east and west sections though the seedpods mature earlier in the eastern than in the western catchment. In addition, the mature *Faidherbia albida* have extensive canopies and offer shelter to wildlife during the hottest part of the day.

At the onset of the wet season, there appeared to be a mass movement of wildlife away from the rivers, into the veld and mountainous regions. In October 1999, before the first rains, large densities of game were observed in the rivers. Within 24 hours of the first substantial rainfall these animals had moved out of the rivers. In the eastern section of the catchment, wildlife was observed to have moved up to 30 km from the riverbed, into the Etendeka mountains and Serengeti plains in the south-eastern catchment and the hills to the west of Hobatere. The aerial survey results of Hobatere confirmed this movement. Prior to the wet season, the population of wildlife within the game park was high but decreased markedly with the onset of the rains. Significant populations of wildlife were observed in the hills surrounding the game park at this time. However, during the cold-dry and hot-dry seasons, the populations of wildlife within the game park increased again as the seasonal grazing and water decreased in the surrounding hills.

Springbok and elephant appeared to live either in areas inhabited by humans or in areas grazed extensively by domestic stock. This is similar to what was reported by Verlinden *et al.* (1998) for the southern Kalahari where springbok were also observed to be unaffected by cattle in an area.

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However, in these areas with a closer association to humans, wildlife had much greater flight distances (movement away from disturbance) than wildlife in other areas of the catchment that had little association with domestic stock or humans.

The reasons for the greater flight distance of wildlife in areas where people and domestic densities are higher could be linked to the following reasons:

- (a) most rural people perceive large mammals such as elephant to be a threat, as they can destroy water points, kill domestic stock and ravage crops. In instances of being provoked, they have been known to kill people. They are generally driven away, either by vehicle and/or firearms when they come close to human settlements, water points or fields.
- (b) plains game (e.g. springbok) are often hunted for food and, although rare, poaching incidents do occur.

Gemsbok, giraffe and zebra appeared to have little tolerance for humans and domestic stock. Their distributions are generally restricted to areas where human settlement and domestic stock populations are low. Verlinden *et al.* (1998) reported a very similar pattern of distribution for gemsboks in the southern Kalahari.

CONCLUSION

The main conclusions that can be drawn from this study are:

- (a) Springbok and elephant are the only wildlife species that were found in rather close association with people and domestic stock.
- (b) Wildlife species have far larger ranges than domestic stock ranges. They tended to occupy the areas of the catchment where there were few pastoral activities. The communities tended to use these less appropriate areas as 'hard times' grazing areas when there were no other grazing alternatives.
- (c) Cattle populations still appeared to be farmed in the traditional manner with cattle numbers falling in the catchment during the hot-dry season. Their wet season ranges appeared to be very dispersed and herd sizes appeared to be larger than during the dry season.
- (d) Small stock populations tended to be located close to human settlements and assured water sources. Their wet season ranges were more dispersed during the hot-dry season. It also appeared that during the wet season herd sizes were larger than during the hot-dry season.

Throughout this study only, limited interactions were reported between wildlife (with the exception of elephants), people and domestic stock. However, due to increasing wildlife and domestic stock populations, eventually domestic stock and wildlife will compete for the same basic natural resources i.e. grazing or browsing and water. As has been observed in other areas of Namibia and Africa (IIED, 1994), wildlife only survive in the same areas as with domestic stock if they can provide a benefit to the community with whom they share the natural resources. This benefit need not actually be financial; it could be as a source of protein or in the use of skins and hides for cultural purposes.

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APPENDIX A

(Flight details for surveys)

Table 3: Flight details for aerial surveys in north-western Namibia, 1999-2000

	Aerial Surveys	
	7-12th October 1999	13-17th April 2000
Aircraft	Cessna 182	Cessna 182
Pilot	A. Hussey (DRFN)	A. Hussey (DRFN)
Observers	Keith Leggett (DRFN) Julian Fennessy (DRFN) Gert v/d Linde (DRFN) John Patterson (MET) Alwyn Engelbrecht (MET) Betsy Fox (MET) H.O. Reuters (SRT) Sarah Maxwell (SRT)	Keith Leggett (DRFN) Julian Fennessy (DRFN) Stephanie Schneider (DRFN) Gert v/d Linde (DRFN) Alwyn Engelbrecht (MET) Betsy Fox (MET) Russel Vinjevold (HGP) Tiens Kotze (consultant)
Recorders	Keith Leggett (DRFN) Julian Fennessy (DRFN) Betsy Fox (MET)	Keith Leggett (DRFN) Julian Fennessy (DRFN)
Flight time		
(a) Hoanib River catchment	(a) 14hrs 30mins	(a) 16hrs
(b) Hoarusib River	(b) 2hrs 30 mins	(b) 2hrs 30mins
(c) Uniab River	(c) 1hr 10 mins	(c) 1hr 10 mins

Table 4: Flight details of aerial surveys conducted in Hobatere Game Park, 1999-2000

	Aerial Survey			
	4th April 1999	8th April 1999	9th October 1999	16th April 1999
Aircraft	Maule V5 JIO	Cessna 182	Cessna 182	Cessna 182
Pilot	Flip Stander (MET)	Steve Braine (HGP)	Arthur Hussey (DRFN)	Arthur Hussey (DRFN)
Observers	Keith Leggett (DRFN) Rudi Loutit (MET)	Keith Leggett (DRFN) Rudi Loutit (MET) Russell Vinjevold (HGP)	Gert v/d Linde (DRFN) Betsy Fox (MET)	Keith Leggett (DRFN) Russell Vinjevold (HGP)
Recorders	Russell Vinjevold (HGP)	Keith Leggett (DRFN) Betsy Fox (MET)	Keith Leggett (DRFN)	Julian Fennessy (DRFN)
Flight times	1hr 45mins	2hr 15mins	1hr 45mins	1hr 45mins
Direction of survey	North/south	East/west	East/west	North/south
Transect width¹	~1000m	~1000m	~1000m	~1000m

¹ Corresponds to a 2 minute turn in a Cessna 182

APPENDIX B

(Wildlife data sheet)

SECTION II

GROUND SURVEY

Year:

Surveyed by:

Area:

				Adult			Sub-adult			Juvenile				
Species	Latitude	Longitude	Mortality	Male	Female	?	Male	Female	?	Male	Female	?	Total	Comments/Observations

SECTION III

A PRELIMINARY STUDY OF GIRAFFE
(*GIRAFFA CAMELOPARDALIS*)

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Keith Leggett
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June 2001

ABSTRACT

The giraffe numbers in Namibia's north-west is relatively unknown but surveys over the past five years estimate a marked increase. Seasonal movements occurred across all the study areas with large fluctuations in the east of the catchment. Research was undertaken to assess the ecology (population dynamics, seasonal distribution, flight and drinking behaviour) of the desert-dwelling giraffe across three study areas in the Hoanib River catchment of north-west Namibia.

Experimental methods are described and their limitations discussed. Giraffe densities across the three study areas are relatively high in comparison to other study areas throughout Africa, while seasonal influences were observed across all study areas. Herd dynamics varied throughout the study areas but were similar to published research undertaken in Africa.

Flight behaviour differed markedly across the three study areas and giraffe mortalities were minimal, yet varied. Importantly, the reliance of giraffe on free-water seems very limited, if non-existent, for the desert-dwelling population.

The future of the desert-dwelling giraffe is dependent on a community-based approach, and charismatic species such as the giraffe is important for non-consumptive and potentially consumptive tourism. Appropriate knowledge and, in turn, management of the giraffe and other species and their habitat is needed to assist in their long-term conservation.

KEY RESEARCH QUESTIONS

Giraffe studies were undertaken in the Hoanib River catchment area to help examine the following questions:

- (a) What are the population dynamics of giraffe occurring in the catchment?
- (b) Has the population of giraffe in the catchment reached saturation levels?
- (c) Does uncontrolled tourism or human influences affect giraffe behaviour in the catchment?

BACKGROUND

Historical Background

Historically, giraffe (*Giraffa camelopardalis*, Linnaeus, 1758) were widely distributed throughout the northern and southern savannah regions of Africa¹ (Skinner and Smithers, 1990; Estes, 1995; Mills and Hes, 1997; East, 1998a; IES, 1998). Today their distribution is patchy and discontinuous, from West Africa to the lower reaches of Southern Africa occurring in 27 countries (Skinner and Smithers, 1990; Estes, 1995; Mills and Hes, 1997; East, 1998a; IES, 1998). Similar to other megafauna throughout Africa and the world (e.g. elephant (*Loxodonta africana*), rhino (*Diceros bicornis*), buffalo (*Syncerus caffer*) and tiger (*Panthera tigris*), shrinkage of available range (food, water and territory) has reduced their numbers and distribution markedly. This reduction has predominantly been associated with human development, but illegal hunting and disease have also played their role (e.g. rinderpest and wildebeest (*Connochaetes taurinus*)) (Skinner and Smithers, 1990; Estes, 1995; Mills and Hes, 1997; East, 1998b).

Giraffe, regardless of their geographical distribution throughout the continent i.e. arid to sub-tropical, are the same species, although up to nine different sub-species (or races) have been described (Dagg, 1971; Skinner and Smithers, 1990; Estes, 1995; East, 1998a). The giraffe of the north-west Namib (*Giraffa camelopardalis angolensis* (Lydekker, 1903)) are not a sub-species but rather a different 'eco-type' or 'bio-type' (same sub-species just adapted to a varied environment) of giraffe, in a similar manner to the desert-dwelling elephant.

¹ Formerly, Gambia and Senegal to Ethiopia and Somalia, south to Central African Republic, NE Zaire, Uganda and Tanzania; E and SW Zambia; S Angola, Zimbabwe and S Mozambique to South Africa, mostly north of the Orange River. Distribution now much restricted; in W Africa still present at least until recently in Mali, Burkina Faso, Niger, NE Nigeria and N Cameroon; in southern Africa, now ranging no further south than N Namibia, Botswana and Mpumalanga (South Africa).

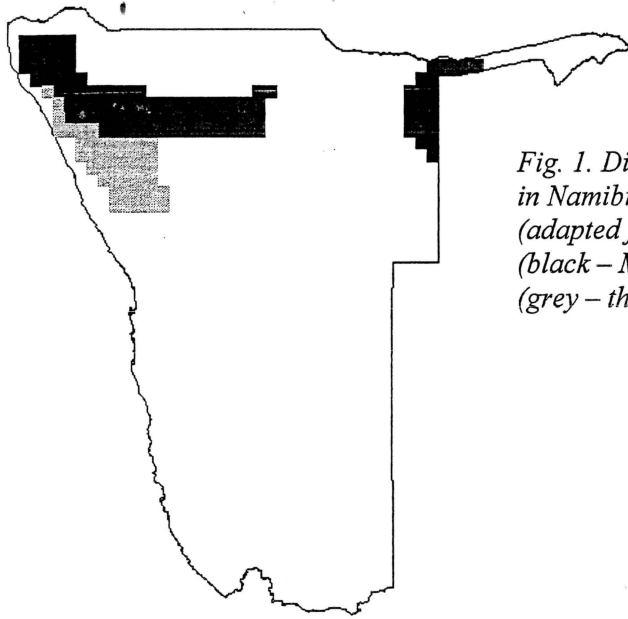


Fig. 1. Distribution map of Giraffe in Namibia: natural occurrence (adapted from MET, 2001) (black – MET data) (grey – this study)

Distribution of giraffe throughout Namibia has been fairly well documented in mammal books, databases and atlases, however, they have not been supported by thorough ground-truthing (Skinner and Smithers, 1990; Estes, 1995; East, 1998a; IEA, 1998). The areas in Namibia which giraffe historically occupied, and still misrepresented in many mammal distribution maps, have long vanished due to development, urbanisation and commercial hunting.

Numerous studies have been conducted throughout Africa in relation to giraffe ecology, such as, population dynamics, behaviour, feeding requirements, translocation capabilities and evolution, although few have focused on giraffe residing in hyper-arid and arid environments (Innis, 1953; Foster, 1966; Foster and Dagg, 1972; Hall-Martin, 1974; Hall-Martin *et al.*, 1975; Leuthold, 1979; Pellew, 1984; Scheepers, 1992; Simmons and Scheepers, 1996; Le Pendu *et al.*, 2000; van der Jeugd and Prins, 2000).

INTRODUCTION

Hoanib River Catchment Study (HRCS) Area

The Hoanib River catchment is one of twelve major ephemeral river catchments that occupy the semi-arid areas of north-western Namibia. All twelve rivers flow into the Atlantic Ocean or end in the Namib Sand Sea. The Hoanib originates in the western edge of the Etosha National Park, flows through commercial and communal farming areas and, near its mouth, traverses the protected Skeleton Coast Park. The Hoanib River catchment occupies an area of 17 200 km², 3% of which lies in private farm lands, 91% in communal farm lands, and 6% is protected in the Etosha National Park and Skeleton Coast Park (Jacobson *et al.*, 1995; Leggett, 1998).

The Hoanib River constitutes the boundary between the former Damaraland and Kaokoland. Since Independence (1990), these two areas have been incorporated into the Kunene and Erongo Regions (see Fig. 2). The Hoanib River catchment can be divided into three broad geographic (and vegetation) sections. The eastern section (east of the Khowarib Schlucht) is relatively densely vegetated with mopane woodland being dominant. The middle section of the Hoanib River (from the Khowarib Schlucht to the Skeleton Coast Park's eastern boundary) is sparsely vegetated. In the western section of the river (from the Skeleton Coast Park boundary to the coast), virtually no vegetation exists outside of the river course. A broad flood plain (some 70km²), which is in front of the coastal dunes, offers substantial grazing for wildlife after flood events during the wet season (Jacobson *et al.*, 1995; Leggett, 1998).

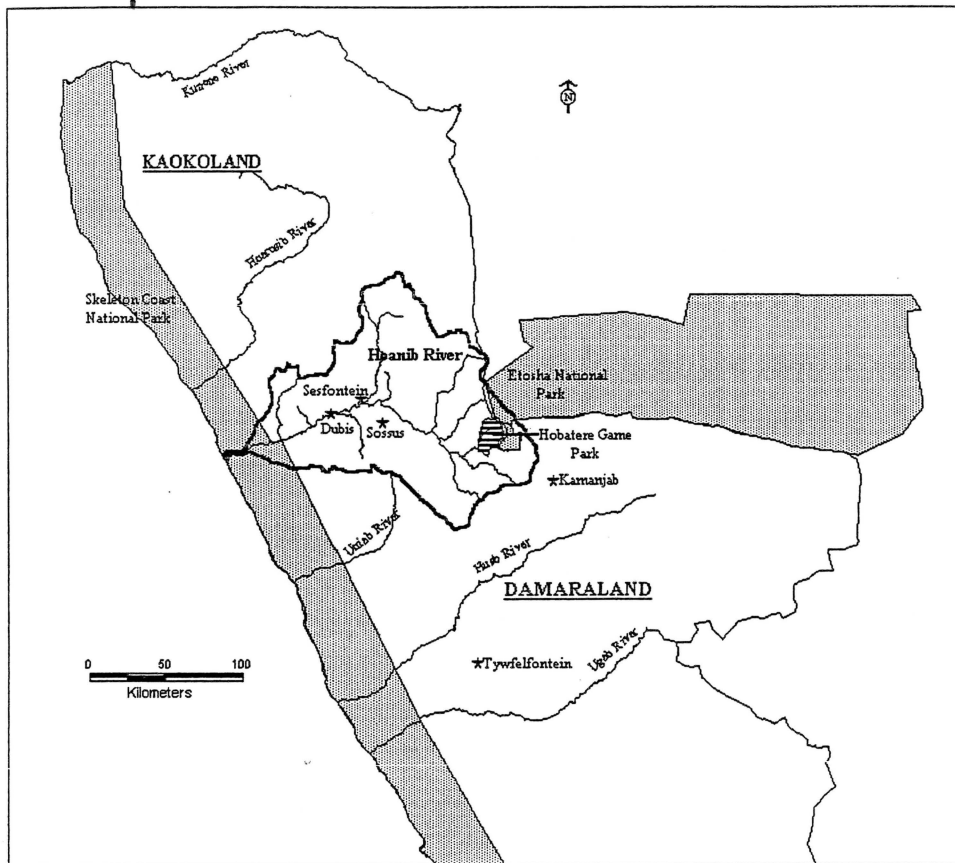


Fig. 2. Location of Hoanib River catchment (including former Kaokoland and Damaraland)

The rainfall in the Hoanib River catchment varies from a mean of 13.2mm at the coast ($n = 50$ yrs), to a mean of 325mm in the eastern section of the catchment ($n = 35$ yrs). This rainfall has a high degree of variability, up to 50% annually in the east and 90% in the west (Jacobson *et al.*, 1995; MWTC, 2000). Drought (or periods of high aridity) is the norm in arid and semi-arid areas and is defined by both Jacobson *et al.* 1995 and Warren and Khogali, 1992, as a period of more than two years with rainfall lower than the long-term mean.

Available free water is thought to play a restrictive role in wildlife movements. However, the adaptations of small and large animal species to life in an otherwise waterless and hostile environment i.e. the Namib Desert and Australia's interior, has been well researched (Southgate *et al.*, 1996; Dickman *et al.*, 1999). The moisture content in the leaves, fruits and pods of shrubs and trees e.g. *Faidherbia albida* and *Commiphora* spp., plays an important role in the survival strategy of the giraffe and other wildlife in this area. Free water may therefore not play a major role in giraffe survival in the north-west.

SECTION III

This study was one of the few research efforts studying giraffe ecology (population dynamics, seasonal movements, and flight and drinking behaviour) in the Kunene Region. The study focussed on three different areas in the Hoanib River catchment. An attempt was made to compare the observations made during this study with relevant historical data and reports.

Giraffe distribution, status and prior research in Namibia's North-west

The desert-dwelling giraffe of the northern Namib Desert occupy a habitat different from most other giraffe on the continent and are almost solely dependent on the riparian environments of the westerly flowing ephemeral rivers. Their presence in such an environment seems to contradict numerous findings of other sub-Saharan giraffe research (Foster, 1966; Foster and Dagg, 1972; Pratt and Anderson, 1982; Leuthold, 1979; Scheepers, 1992; Le Pendu *et al.*, 2000; van der Jeugd and Prins, 2000).

An historical overview of giraffe numbers and distribution in the Kunene Region is essentially unknown, with the earliest numbers of 200 reported by Shortridge in 1934 (see Table 1). However, they have roamed throughout the Kunene Region, and in turn the Hoanib River catchment, for far longer. Rock paintings at Sossus, west of Khowarib in the Hoanib River catchment, Kamanjab and Twyfelfontein, in the southern Kunene Region, depict large herds of giraffe as well as hunting scenes (see Fig. 2).

Table 1: Historical overview of estimated Giraffe numbers in the Kunene Region (former Damaraland/Kaokoland), 1934-1998

Researcher (Year)	Estimated Giraffe Numbers
Shortridge (1934)	200
Viljoen (1982b)	317
Carter (1990)	285
Loutit in Carter (1990)	335
Scheepers (1992)	450
Loutit (1995)	267
MET (1998)	548
MET (2000)	1105

Shortridge (1934) reported a lack of giraffe residing in the region west of the Sesfontein and Kaoko-Otavi line; although the facts and figures provided to him were based on 'native information' from communities further east which since have proven unreliable (Joubert and Mostert, 1974). In more recent history, the estimated numbers of giraffe in the Kunene Region varied little from Viljoen's figures of 317 in 1982 to Loutit's estimates of 267 in 1995. Scheepers (1992) figure of 450 giraffe is high in comparison to all previous studies in the area.

Theoretically, giraffe are able to give birth every 2 years; gestation period of 457 days (Foster, 1966; Skinner and Hall-Martin, 1975), however, the estimated population growth from 1998 ($n = 548$) to 2000 ($n = 1105$) (based on the MET preliminary results) is in excess of 100%. This is unlikely in the light of their slow gestation period. However, these and other estimates are the most comprehensive figures available.

The giraffe estimates in the former Kaokoland area are shown in Table 2. The important grasp from this data is the smaller percentage of giraffe residing in the Kaokoland area, compared to the former Damaraland area. Three areas, which lie within the former Damaraland area as well as the Hoanib River catchment (Hobaterre GP, the Serengeti plains and Grootberg/Etendeka mountain range), have abundant wildlife, including approximately half of the giraffe population of the Kunene Region. Over the past three decades, estimated giraffe numbers in Kaokoland were reported as high as 80 in 1977, yet decreasing to 39 in 1995 (see Table 2). This population change indicates a 'bell-shaped' growth pattern. Translocation of giraffe from the Etosha NP into the westerly environments of the Kunene Region also occurred in the early 1980s. This influx increased the resident populations occurring in the Hoarusib and Huab Rivers, though had little impact on the those in the Hoanib River and Hobaterre GP (Scheepers, 1992; MET pers. comm.)

SECTION III

Table 2: Historical overview of estimated Giraffe numbers in Kaokoland, 1969-1995

Researcher (Year)	Estimated Giraffe Numbers
De Villiers (1975) in 1969	58
Owen-Smith (1970)	70
De Villiers (1975)	79
Viljoen (1980) in 1977	52-60
Viljoen (1982a) in 1977	80
Carter (1990) in 1982	45
Carter (1990)	34
Loutit (1995)	39

Two giraffe studies have taken place in the Hoanib River catchment, both with the Ministry of Environment and Tourism: Scheepers (1992; pers.comm.) in the late 1980s to early 1990s; and Loutit (pers. comm.) in 1996 in the Hobatere GP only.

Scheepers' research was multi-faceted and included an attempt to understand certain physiological aspects (e.g. water retention) of the desert-dwelling giraffe as well as their basic ecology (population dynamics, flight behaviour and feeding preferences), though little information is currently available from this study.

Loutit's research focused on Hobatere GP within the Hoanib River catchment (Loutit pers.comm.). Field surveys were conducted to identify the impact of giraffe on vegetation, and specifically *Boscia albitrunca*. This research was conducted over a six-month period and this work remains unavailable.

The focus of this study was on three areas within the Hoanib River catchment – the lower Hoanib River, Ombonde River and Hobatere GP (see Fig. 3). Each study area was located in different landforms, rainfall regimes and vegetation types.

The object of the study was to conduct, collate and update (where applicable) essential baseline data on giraffe ecology in the Hoanib River catchment (population dynamics, seasonal movements, flight disturbances and drinking behaviour of giraffe).

METHODS

Giraffe Database

The details of each identified giraffe were recorded on identification sheets (see Appendix A) and then its bio data (horn structure, scars, colour and tail hair) entered into the database. Details of unknown giraffe could also be entered by performing a search on the bio data. Photographs were also stored with the key characteristics of the individual. Future researchers will be able to update any of this information by completing identification sheets and accompanying photographs, thus keeping the database current.

The giraffe database was developed in conjunction with Barbara Paterson and forms part of a larger Hoanib River catchment database created for wildlife surveys, elephant identifications and wetland surveys. It will be made available to the wider research community (e.g. Ministry of Environment and Tourism, NGOs and Community Based Organisations (CBOs)) and will hopefully be of assistance to all-future researchers in Namibia.

Study Area

Three different study areas across the Hoanib River catchment, in both precipitation levels and with relation to human pressures, were used as the basis for the giraffe research (see Fig 3).

1. The lower Hoanib River study area comprised the lower Hoanib River from Dubis wetlands west to the Hoanib Floodplain in the Skeleton Coast National Park, and included the Ganamub River, a tributary. This study area was limited to the riverbed and immediate surrounds, as the vegetation existing along this linear oasis is the source of life for most wildlife in this area. No villages or settlements exist along its course. There is, however, a seasonal settlement at the top of the Ganamub River and a campsite is being established near the Dubis wetland. Tourism is predominant along this section of the Hoanib River. Precipitation levels average 10-100mm per annum across the study area. The transect length was 87km.

SECTION III

2. The Ombonde River study area extended from the Khowarib Schlucht in the middle of the catchment to the Kamdescha veterinary gate in the east, covering a transect length of 50km. This study area is also a linear oasis. However, available vegetation outside the river is greater than the lower Hoanib River due to the increased precipitation in the east (approximately 300mm per annum). Tourism is minimal throughout the Ombonde River, while seasonal and permanent settlements are dotted along or near its course.
3. Hobatere Game Park (GP), a concession area in the east of the catchment, served as the third study area. The park was previously a hunting concession until the early 1990s and now exists solely as a non-consumptive tourist reserve. Not being of a linear nature, but rather a 'semi-closed' environment, the entire park was used as the base for the study. The study area was approximately 32,000km²

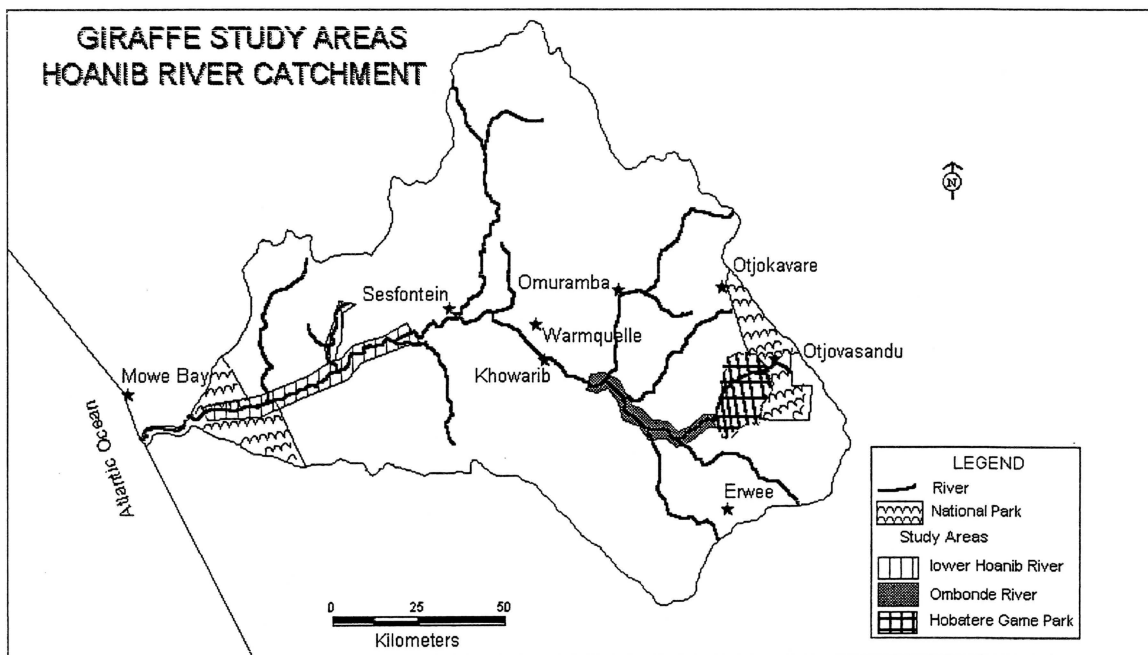


Fig. 3: Giraffe Study Areas in the Hoanib River catchment.

Field Sampling Techniques

Observations of giraffe ecology (population dynamics, seasonal movements, flight and drinking behaviour) were conducted periodically over a two-year period (between October 1998 and October 2000). The data was analysed on the basis of three distinct seasons as described by Viljoen (1988): wet (January to April), cold-dry (May to August) and hot-dry (September to December) season.

Information and observations were limited throughout the wet season due to the heavy rains and saturated riverbeds.

Population Dynamics

The notion and structure of a giraffe herd was defined by Backhaus in Foster and Dagg (1972) e.g. one or greater, as "the number of the same species of animal that move together and are usually engaged in the same activity, at any one time". Using this definition, this study defined herds as those individuals observed within less than 1km from each other. Observations were undertaken bi-monthly (often more frequently) by vehicle over a 2-year period as part of a greater wildlife survey.

Herd dynamics of giraffe, i.e. numbers, age, sex and ratios of individuals, were recorded immediately upon encounter² (see Appendix A for example survey form). Exact Global Positioning System (GPS) co-ordinates were recorded for either the individual or herd observed, and plotted on a Geographical Information System (GIS). Individuals were then classified into one of the following classes and age categories established (adapted from MET, 1998) (see Fig.4).

ADULT

- Class VI** Black Bull
- Class V+** Mature Bull
- Class V** Mature Cow

² When the flight patterns were swift or erratic and individuals fled before a clear observation could be made, the animals were then assumed as either unknown adult, sub-adult or juvenile.

SECTION III

SUB-ADULT

Class IV Immature Bull/Cow

Class III Immature Bull/Cow

JUVENILE

Class II Juvenile Bull/Cow

Class I Juvenile Bull/Cow

Class + New Born

All class types for individuals in a herd were based on a height comparison with the mature cow (Class V). Class IV was recorded as an immature animal with its head lower than that of a mature cow but higher than the middle of her neck. Class III was recorded as an immature animal with its head equal to the middle of the mature cow's neck. Class II was recorded as a juvenile whose head was approximately a third of the way up the mature cow's neck, while Class I was recorded as a juvenile animal with its head reaching the base of the mature cow's neck. Class -1 was recorded as a new-born individual which still had its umbilical cord attached (not observed during this study).

Mature Bulls were either recorded as Class V+, if they were adult yet no dark coloration, while Class VI individuals were recorded as those with dark coloration's (commonly referred to as 'Black' Bulls). For those giraffe observed as individuals or in bachelor herds, categorisation was based on prior identification, practice and field knowledge.

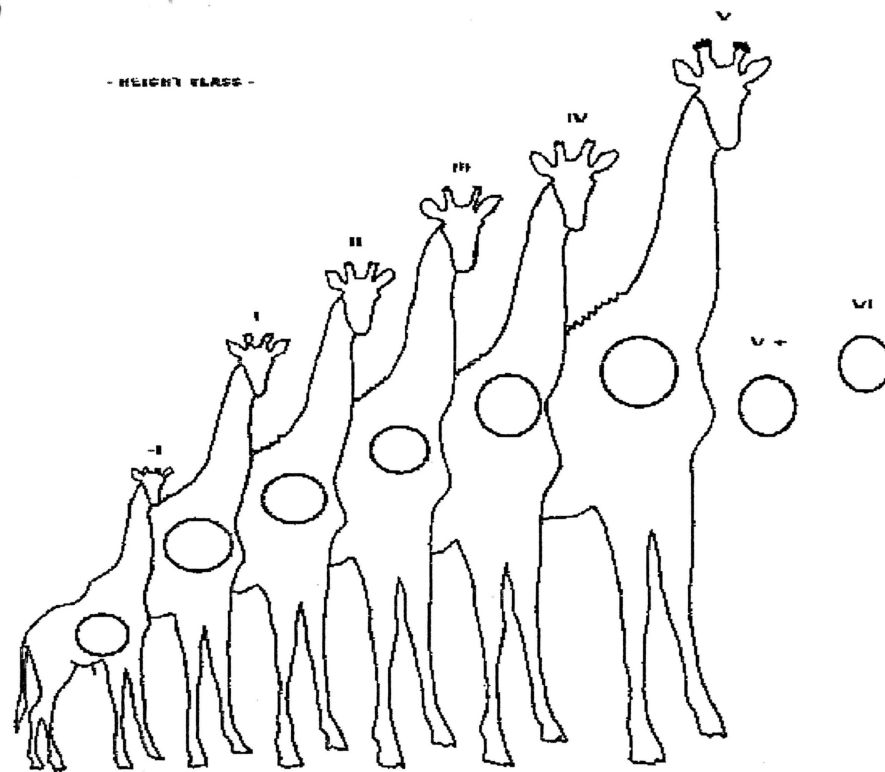


Fig. 4: Height class/age categories used for giraffe identification

Seasonal variation in herd sizes was analysed to identify if any correlation existed. Food or predatory aggregations have been observed previously in numerous plains' ungulates and therefore herd sizes were recorded to identify if such behaviour occurs in the arid environment of Namibia's north-west.

SECTION III

Flight Behaviour

Assessing the varying flight behaviour patterns of giraffe in the three study areas was important in understanding the varying degrees of disturbance. Wildlife disturbances are prevalent in numerous forms and may either have a direct or indirect impact on the giraffe and other wildlife in an area. However, tourism and hunting are the two key factors that need to be considered when assessing the contrast in flight behaviour and, in turn, disturbances between the study areas. Flight was defined as the distance travelled due to a direct or indirect impact or disturbance i.e. vehicle, noise and hunting, and distance measured from the initial observation. Five categories were created to assess the flight distances observed:

Category 1	0-10m	(no significant flight, possible fright)
Category 2	10-25m	(small flight distance)
Category 3	25-50m	(medium flight distance)
Category 4	50-100m	(large flight distance)
Category 5	100m or more	(extreme flight distance)

Seasonal Distribution

Seasonal distribution data of giraffe herds was collected using the GPS co-ordinates of where herds were observed. This data was stored on a database which was linked to a MapInfo GIS programme. The individual circles on the maps represent individual giraffe herds for the lower Hoanib and Ombonde River while in Hobatere GP total numbers were plotted.

Mortalities – Natural Senescence and Predation

When mortalities were observed, a rapid method of ageing the giraffe carcasses was important because of both time and location constraints. The method involved a quick visual assessment of the animal e.g. size, colour and dentition, so as to assess the approximate age and possible cause of death i.e. predator spore, natural senescence. Swabs and skin samples were also taken from

one animal for further testing by the State Veterinary Services to detect for the possibility of anthrax (*Bacillus anthracis*).

Drinking Behaviour

Any bouts of giraffe drinking in the study areas were recorded. Time, location, duration and the water quality (visual and chemical) were recorded. It was rare to observe an individual drinking, therefore any splayed spoor at waterholes were recorded, as this can be indicative of drinking having taken place.

Individual Identification

Identification of individual species was attempted using diagnostic features distinctive to each giraffe. The individuals were identified and their features recorded into the database to assist in future sightings and record individual movements. The following diagnostic features were used for identifying individuals:

- **Sex** – the male can be identified by his distinctive penile sheath under the belly, approximately a third of the way between his back and fore legs. When mature, the males are predominantly larger than the females and thus can be identified by size.
- **Neck patterns** – the right and left-hand side neck patterns vary from each other, as well as between individuals.
- **Body coloration** – males become generally darker as they age.
- **Horn phenology** – male horns are predominantly larger and thicker in size, and mature males usually have no hair tufts on the horns due to fighting. Females have comparatively thinner horns with hair tufts protruding from them.
- **Tail phenology** – the length, presence, quantity and shape of tail hair can vary between individuals.

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Horn and tail phenology and body coloration cannot be solely used as diagnostic features for accurate identification. However, in combination with other dominant features (e.g. neck pattern or sex) repetitive recognition of individuals can be made.

Browse

Browse heights within an area can provide a good indication of use and in turn which animals have been feeding in that environment i.e. elephant and giraffe are able to feed much higher than domestic stock, thus distinctively high browse lines (>3m). For individual trees, the height to which the *Faidherbia albida* had been browsed was recorded, an assessment of which species had been using/feeding off the tree. Initially the browse line was categorised into one of the following: (i) Definite, (ii) Some or (iii) Nil.

The height of the browse line was measured, from ground level to the height where the canopy began. Three height categories were used:

- (i) 0-1.5m
- (ii) 1.5-3m
- (iii) >3m

STATISTICAL ANALYSIS

Strip Count Method

The number of giraffe per unit area was calculated using an adapted line transect method (see Burnham *et al.*, 1980; Ben-Shahar, 1995). This was done in order to calculate the giraffe densities in relation to the saturation levels of the riparian vegetation. The method assumed that all animals were detected and recorded within the area, with Density (**D**) estimated as:

$$D = n / LW$$

The strip of area (or linear environment) in this instance is LW , where, L = length of transect, W = width of the transect area, and n = number of animals.

The length of transects (L) was determined using a fixed vehicle GPS and its distance function. The width of the transect (W) proved more difficult, however, and only an indication of the width of the rivers was made by taking measurements as 5km intervals. An average was then made of the aggregate widths. The linear environment of the river and its harsh surrounds are limiting factors for food availability for giraffe. A good indication of density and usage of the riparian environment could be obtained, as sightings away from the riverbed were rare. The steep cliffs and lack of vegetation outside the riverbed provided a favourable environment for observation. Four assumptions were required to make any valid inferences with regard to population density from any sample and in any given area (Burnham *et al.*, 1980; Ben-Shahar, 1995):

1. objects on the line of transect are detected with certainty
2. objects do not move in response to the observer before being detected
3. perpendicular distances are accurate (average widths of the river used)
4. detections are independent events.

The average transect width for the lower Hoanib River study area was 228 metres and 87km in length, while the Ombonde River study area transect was 50.3 km in length, with an average width of 177.5 metres.

Density analysis of Hobatere GP was based on the parks total area; 32,000 km², not the line transect method as for the two riparian areas.

RESULTS

Kunene Region (former Kaokoland and Damaraland) – Historical Giraffe Herd Averages

Over the greater part of the last two decades (1981-2000), the giraffe populations have been relatively stable (see Fig. 5). A slight increase was observed in population averages during 1999-2000; Hoanib River catchment (4.3 per herd), when compared to the previous two decades of historical data from the Kunene region (3.7 per herd). More intensive surveys during this study may have attributed to marginally larger average herd sizes. However, in 1983, 1988 and 1995 similar herd numbers were observed to that of this study (4.3, 4.2 and 4.4 per herd, respectively).

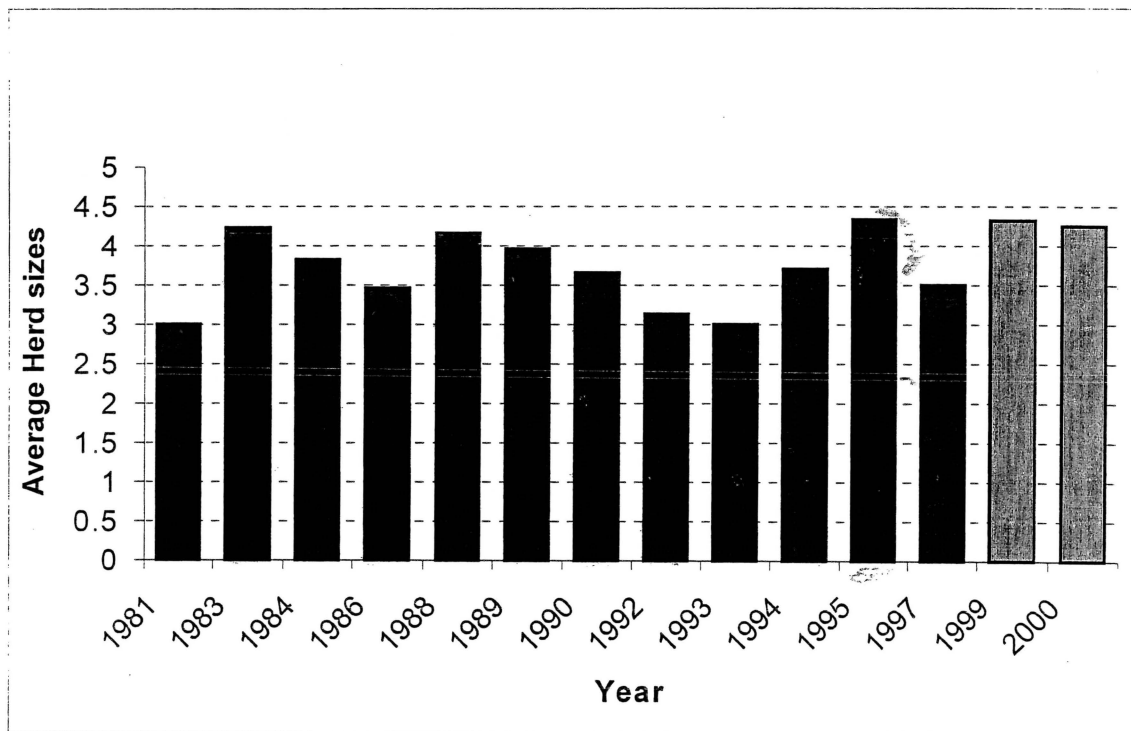


Fig. 5: Historical Giraffe Herd Size Averages– Kunene Region, 1981-2000 (source: Carter, 1990; Loutit, 1998; MET, 1998; and this study)

The previous research surveys vary markedly in numbers (see Table 3) and locations. In some years the count numbers were too small to provide useful data.

Table 3: Number of actual counts and sightings of Giraffe, Kunene region, 1981-2000
(source: Loutit, 1998; MET, 1998; and this study)

Year	No. of Counts	Total No. of Giraffe sighted
1981	12	36
1983	23	94
1984	37	145
1986	155	540
1988	66	279
1989	75	301
1990	62	230
1992	104	322
1993	53	162
1994	21	74
1995	23	104
1997	6	21
1999	99	419
2000	50	217
Total	786	2944
Avg. Herd Populations		3.79

Hoanib River Catchment – Historical and Current Giraffe Numbers

The historical survey data available for the Hoanib River catchment is neither consistent nor detailed throughout the last two decades, but provides an adequate basis for population changes over time (see Table 4-6). These results are not indicative of the average usage of the environments, but rather show a maximum number of individuals observed at any time. Other work requirements placed time constraints on the study and it was not possible to identify all individual giraffe diagnostic features. As the giraffe study was one small portion of the comprehensive Hoanib River catchment study, only a few individuals were identified and stored on the database for follow-up research.

Historically, the giraffe numbers in the lower Hoanib River varied little and indicate a fairly stable population – 29 in 1977 (Viljoen, 1980) to 35 in 1992 (Scheepers, 1992). The variances in numbers reported in different years by various authors may be attributed to numerous factors including season, observers and experience. Viljoen's (1980) and Scheepers' (1992) results are the most comprehensive and provide the best analysis, with an annual increase in population of 1.6% over the last 11 years. Between Scheepers' study (1992) and this study, the population growth (taken for the hot-dry season) was 1% annually over the last 8yrs, not consistent with the Kunene Region estimates. These results are not indicative of the average use of the riparian forest by the giraffe in the river, but rather indicate a maximum number of individuals observed at any time.

Table 4: Historical and Current Giraffe numbers, lower Hoanib River (including Skeleton Coast Park) 1982-2000

Researcher (Year)	Giraffe Numbers
Viljoen (1980) in 1977	29
Cooper (1980) in 1979	20
Cooper (1980)	11
Carter (1990) in 1982	6
Carter (1990)	20
Scheepers (1992)	35
Loutit (1995)	16
Loutit (1996)	15
This Study	
Wet Season (1999)	20
Cold-Dry Season (1999)	29
Hot-Dry Season(1999)	-
Wet Season (2000)	14
Cold-Dry Season (2000)	19

Hot-Dry Season(2000)	38
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Throughout the study period, giraffe numbers in the lower Hoanib River increased from 1999 to 2000; 29 to 38 giraffe respectively, with reduced numbers observed during the wet ($n = 17$) and cold-dry season ($n = 25$) (see Table 4). No data for the 1999 hot-dry season was available due to unusually high rainfall and access was unavailable. The slight increase in numbers during the hot-dry season ($n = 38$) may be attributed to the limited food availability within and outside the river course, while the notion of the giraffe population reaching saturation level may be evident (finite resources).

No historical assumptions regarding giraffe numbers can be drawn for the Ombonde River due to the lack of data (see Table 5). Only two historical data sets were available, 1990 and 1995, though they represented the greater Ombonde/Serengeti area.

Table 5: Historical and Current Giraffe numbers in the Ombonde/Serengeti area, 1990-2000

Researcher (Year)	Giraffe Numbers
Carter (1990)	132
Loutit (1995)	98
This Study	
Hot-Dry Season (1998)	42
Wet Season (1999)	0
Cold-Dry Season (1999)	4
Hot-Dry Season(1999)	41
Wet Season (2000)	0
Cold-Dry Season (2000)	6
Hot-Dry Season(2000)	43

This study observed a stable number of giraffe using the river during the hot-dry season; 42 in 1998; 41 in 1999 and 43 in 2000. The results for the cold-dry and wet seasons varied markedly compared to the hot-dry season. During the cold-dry season (1999-2000), only a small number of giraffe were observed in the river ($n = 5$), while no giraffe were observed in the Ombonde River during the wet season (1999-2000). The lack of giraffe in the Ombonde River during the wet season was the most notable.

An increased number of giraffe in Hobatere GP, from 63 (1990) to 109 (2000), was observed over the past decade, although seasonal information is unknown (see Table 6). Wet season figures

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were highest ($n = 114$), followed by the hot-dry ($n = 97$) and the cold-dry seasons ($n = 67$) for 1999-2000. A slight decline in numbers for the hot-dry season may be attributed to the above average mean rainfall (1999/2000) in the east of the catchment (Leggett *et al.*, 2001b)

Table 6: Historical and Current Giraffe numbers in the Hobatere Game Park (GP), 1990-2000

Researcher (Year)	Giraffe Numbers
Carter (1990)	63
Loutit (1995)	60
MET/HRCS (1999)	73
This Study	
Wet Season (1999)	121
Cold-Dry Season (1999)	67
Hot-Dry Season(1999)	-
Wet Season (2000)	109
Cold-Dry Season (2000)	-
Hot-Dry Season(2000)	120

Herd Size

In the lower Hoanib River, a gradual decline in the frequency of larger herd sizes was observed (see Table 7). Data was available for 79 herds and varied from a solitary giraffe to a herd of twelve. A herd size of one was the most commonly observed, representing 32% of all observations. Herd sizes of two and three each represented 16% of all observations, and herd sizes of one to three represented almost two-thirds of all herds observed. No evidence of a correlation between herd sizes and seasonal congregation or aggregation was observed in the lower Hoanib River (wet season $r^2 = 0.45$, $P < 0.001$; cold-dry season $r^2 = 0.41$, $P < 0.001$; hot-dry season $r^2 = 0.34$, $P < 0.001$).

Table 7: Size of giraffe herds, lower Hoanib River, 1999-2000 (as percentage)

	1	2	3	4	5	6	7	8	9	12	No. of Herds	% of Herds
Wet Season	40	20	15	10	10	15					20	25.3
Cold-dry Season	26	18.5	22.2	11.1		3.7	7.4		3.7	7.4	27	34.2
Hot-dry Season	31.2	12.5	6.3	3.1	6.3	6.3	6.3	6.3	6.3	3.1	30	40.5
No. of Herds (%)	25	13	13	8	4	4	4	2	3	3	79	
No. of Herds sighted (%)	32	16	16	10	5	5	5	3	4	4		100

Data on 30 herds were available for the Ombonde River, varying from one individual to fourteen (see Table 2). No giraffe were observed during the 1999 and 2000 wet season. A herd size of one was the most commonly observed, representing 38% of all observations, while 26% were observed in pairs. These two herd size categories (1 and 2) comprised almost two-thirds of all herds observed. Greater numbers of herds were observed during the hot-dry season ($r^2 = 0.66$, $P < 0.001$), correlating with the fruiting season of *Faidherbia albida*. For the first half of the year, little or no herds were observed using the river, as the available resources outside the river course were abundant. Compared to the Kunene Region average herd size of 4.3 (see Fig. 6), these results were far less. However, large herd sizes observed increase the overall average due to the small total herds surveyed.

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Table 8: Size of giraffe herds, Ombonde River, 1998-2000 (as percentage)

	1	2	3	5	6	7	8	14	No of Herds	% of Herds
Wet Season									0	0
Cold-dry Season	75	25							4	13.3
Hot-dry Season	34.6	27	7.7	7.7	7.7	3.8	7.7	3.8	26	86.7
No. of Herds	12	8	2	2	2	1	2	1	30	
% of Herds observed	38	26	6	6	6	3	6	3		100

The majority of herds observed in Hobatere GP were solitary, closely followed by herd sizes of two and then three (see Table 3). The one to three herd groups (1-3) accounted for 53% of all observed herds, slightly less than recorded in the other two study areas. The biggest herd size were observed in the Hobatere GP. Incidental sightings of herds comprising of 19 and 22 individuals were also observed after good rains in 1999/2000, but were not part of a fixed count.

Table 9: Size of giraffe herds, Hobatere Game Park (GP), 1999-2000 (as percentage)

	1	2	3	4	5	6	7	8	10	11	12	13	16	26	No of Herds	% of Herds
Wet Season	10	15	15	10	10	10	15				5	5	5		20	26.3
Cold-dry Season	29.4	11.8	11.8	11.8		11.8	17.6			5.8					17	22.4
Hot-dry Season	33.3	15.4	12.8		15.4	2.6	5.1	7.6	2.4		2.6			2.6	39	51.3
No. of Herds	20	11	10	4	8	5	8	3	1	1	2	1	1	1	76	
% of Herds observed	26	14	13	5	11	7	11	5	1	1	3	1	1	1		100

Herd Dynamics

Male versus female ratios observed within the three study areas indicated a slightly higher percentage of males in both the lower Hoanib and Ombonde Rivers, compared to Hobatere GP (see Table 10).

Table 10: Males vs. Females and Age categories, Hoanib River catchment, 1998-2000 (as percentage)

Area	No. of Observations	Males vs. Females (%)			Age categories (%)			
		Male	Female	Unknown	Adult	Sub-adult	Juvenile	Unknown
Lower Hoanib River	267	37	51	12	64	30	6	-
Ombonde River	167	34	21	45	53	17	6	24
Hobatere GP	228	27	62	11	56	24	20	-

The age structure and sex ratios of giraffe in the lower Hoanib (m:f = 1:1.38) and Ombonde Rivers (m:f = 1:1.62) were skewed, representing a climax population; with adult : subadult : juvenile ratio of 10.7:5:1 in the lower Hoanib River and 8.8:2.8:1 in the Ombonde River. More males than females were observed in the Ombonde River although the data was limited due to their large flight distances (in 45% of observations, sex could not be established and in 24% age was unknown). Scheepers (1992) reported that the sex ratio in the lower Hoanib River was slightly higher than observed during this study (m:f = 1:1.6).

The larger percentage of females observed at Hobatere GP (m:f = 1:1.6) also correlated with the higher juvenile percentages observed, 20% versus 6%, in both the lower Hoanib and Ombonde Rivers. No offspring was observed throughout the study period.

SECTION III

Population Density – Hoanib River Catchment and other areas in Africa

Although the study areas surveyed in Namibia were relatively small compared to other study areas in Africa, the densities observed seasonally were, extremely high (Fig. 11.1 and 11.2).

As this study focussed on the impact of giraffe on riparian and semi-closed environments, it can be inferred that throughout the three areas, with the exception of the Ombonde River (wet and cold-dry season densities), that giraffe densities were higher than observed in other areas throughout Africa.

Fig 11.1: Density/km² of Giraffe throughout different areas of Africa

Area	Year	Size (km ²)	Density (n/km ²)	Source
Arusha National Park, Tanzania	1979	119	3.96	Pratt and Anderson, 1982
Kruger National Park South Africa	1997	-	2.5	Mills and Hes, 1997
Fleur de Lys, Sth. Africa	1958	80	1.2	Innis, 1953
Manyara National Park, Tanzania	1991	100	0.85	van der Jeugd and Prins, 2000
Nairobi National Park, Kenya	1970	114	0.75	Foster and Dagg, 1972
Tsavo East National Park, Kenya	1970-74	-	0.2-0.3	Leuthold, 1979
Baragoi, Kenya	1963	2040	0.01	Stewart and Zaphiro, 1963

The lower Hoanib River had a slightly higher density throughout the cold-dry and hot-dry seasons (0.93 ± 0.73 per km² and 1.06 ± 0.79 per km², respectively) compared to the wet season (0.72 ± 0.27 per km²). The Ombonde River carried far fewer or no giraffe densities in the wet and cold-dry seasons (0 and 0.59 ± 0.07 per km², respectively) though a marked increase in densities was observed during the hot-dry (3.62 ± 1.96 per km²). Hobatere GP, however, experienced a higher density in the wet season (3.6 ± 0.28 per km²) compared to the other seasons, although high densities were observed year round.

Table 4.2: Density/km² of Giraffe, Hoanib River catchment, 1998-2000

Area	Year	Size (km ²)	Density (n/km ²) (S.D)
lower Hoanib River			
Wet Season	1999-2000	19.8	0.72 ±0.27
Cold-Dry Season	1999-2000	19.8	0.93 ±0.3
Hot-Dry Season	1999-2000	19.8	1.06 ±0.79
Ombonde River			
Wet Season	1999-2000	8.9	0
Cold-Dry Season	1999-2000	8.9	0.59 ±0.07
Hot-Dry Season	1998-2000	8.9	3.62 ±1.96
Hobatere Game Park (GP)			
Wet Season	1999-2000	32	3.6 ±0.28
Cold-Dry Season	1999-2000	32	2.09 ¹
Hot-Dry Season	1999-2000	32	2.52 ±1.76

¹Insufficient data available for further analysis

SECTION III

Flight Behaviour

The flight behaviour of giraffe throughout this study indicated a marked difference between the three study areas and across the seasons.

The smallest flight behaviours were observed in the lower Hoanib River, averaging 0–10m – ranging from no observed flight to category 2 (0m to 25m). Scheepers (1992) recorded reduced flight behaviour of giraffe in the lower Hoanib River over a three year period, accrediting it to habituation to increased tourism – average 157m (1986) to 114m (1988) (or category 5). The results in this study are far less than that reported by Scheepers (1992) and an indication of increased habituation over the past decade and a half.

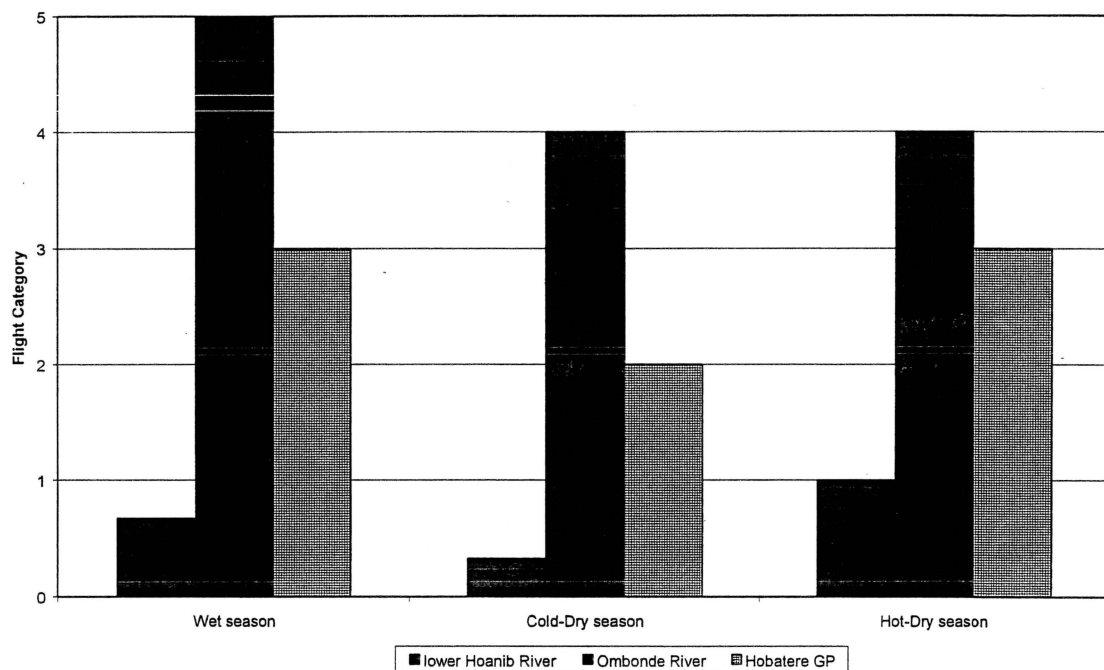


Fig. 7: Flight behaviour of Giraffe, Hoanib River catchment, 1999-2000

Giraffe in the Ombonde River had far larger flight distances than those in the other two areas, averaging >50–100m – ranging from categories 3 to 5 (>25m to >100m). Hobatere GP's giraffe study revealed medium flight behaviour patterns, averaging >10–25m – ranging from category 2 to 3 (>10m – 50m).

Mortalities

Eight mortalities were observed throughout this study (see Table 12). None of the mortalities observed in the catchment was assumed directly attributed to disease or drought. Five cases were a result of natural senescence (all mature bulls; class V/VI), two cases were due to predation by leopard (*Panthera pardus*) (both calves – class I/II) and one was a result of an impact with fences (young bull; class IV). The impact of fences may be more detrimental if the predator population continues to increase as well as the erection of more fences on communal land.

Table 12: Observed mortalities, Hoanib River catchment, 1998-2000

Sex	Age Class	Year	Location	Cause of Death	Source (pers.comm.)
Male	VI	1998	Ombonde River	Natural	This study
Male	IV	1999	Hobatere G.P.	Fence	This study
Male	VI	1999	lower Hoanib River	Natural	Gilchrist, 1999
Unknown	IV-V	1999	Hobatere G.P.	Natural	Vinjevold and Braine, 1999
Unknown	IV-V	1999	Hobatere G.P.	Natural	Vinjevold and Braine, 1999
Unknown	IV-V	1999	Hobatere G.P.	Natural	Vinjevold and Braine, 1999
Unknown	I	1999	Hobatere G.P.	Predator	Vinjevold, 2000
Male	II	2000	Hobatere G.P.	Predator	McClure, 2000

Scheepers (1992) observed three mortalities in the lower Hoanib River – two by natural causes (both old) and one by lion (*Panthera leo*) kill (3yr-old calf); the pride had since been shot.

Browse Heights

The browse heights observed along the entire Hoanib River indicate a strong correlation between those areas populated by megafauna (e.g. giraffe and elephant) and those populated by either domestic stock and/or wildlife seasonally (see Figs. 8 and 9).

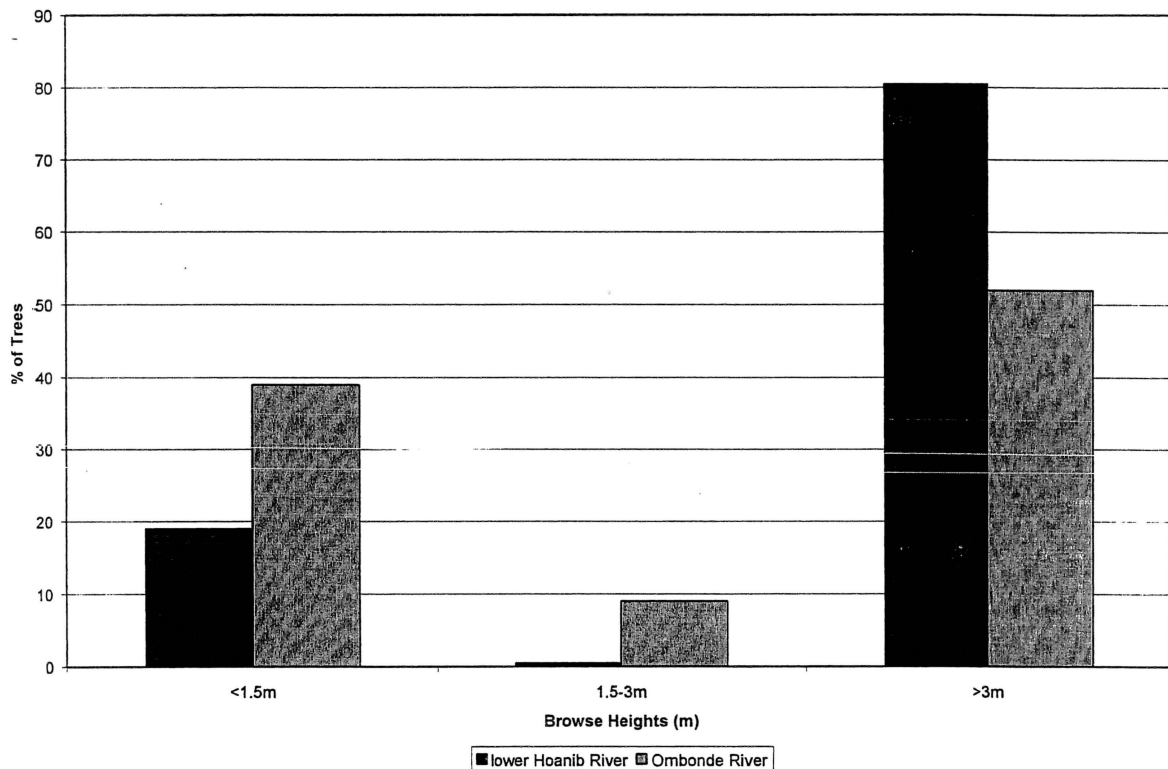


Fig. 8: Browse heights of *Faidherbia albida* in the Hoanib River, 1998-1999 ($n = 3845$)

A marked variance was observed in browse heights in the lower Hoanib River ($n = 788$), compared to the Ombonde River ($n = 1089$). 80.9% ($n = 1446$) of all *Faidherbia albida* in the lower Hoanib River had a browse height greater than 3m, indicating a large influence of giraffe and elephant. The percentage of browse heights greater than 3m observed in the Ombonde River ($n = 568$) (52.1%) was relatively high, however this varied in stretches of the river which wildlife seasonally frequented. At least double the percentage of trees with browse heights at or below 1.5m were observed in the Ombonde River ($n = 418$), compared with the lower Hoanib River ($n = 340$); (38.4% and 19%, respectively). Minimal browse heights were observed between 1.5m and 3m in the lower Hoanib River (0.1%), corresponding to the *Faidherbia albida* being heavily browsed upon by wildlife when they are immature.

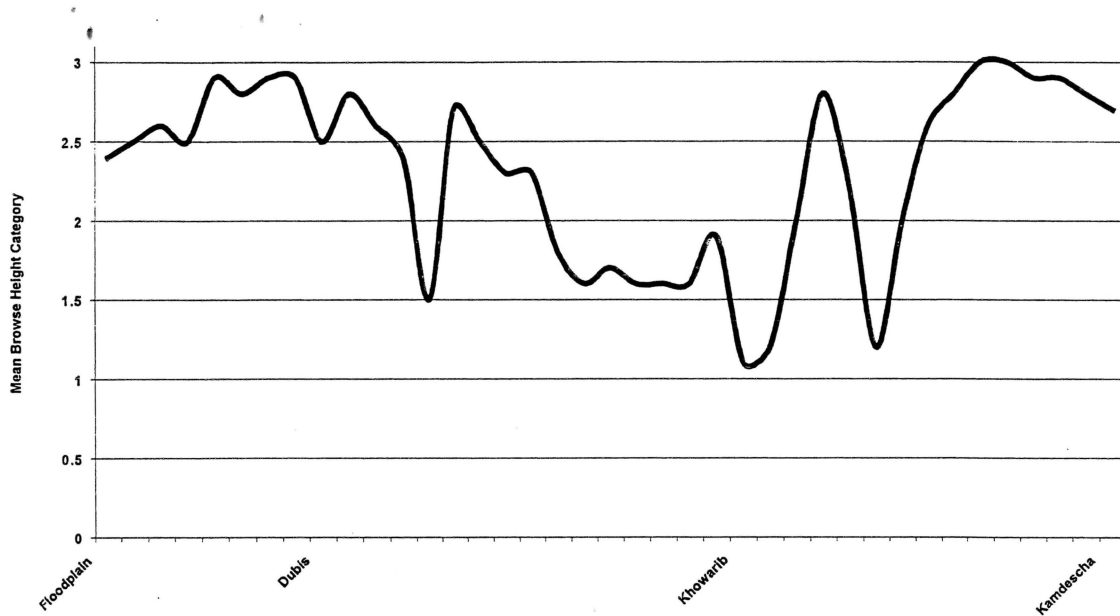


Fig. 9: Mean browse heights of *Faidherbia albida* per 5km, Hoanib River, 1998-1999 (n = 3845)

A positive relationship was observed between villages and domestic stock ranges, and lower mean browse heights (see Fig 9) (Leggett *et al.*, 2001a). The lower mean browse heights of *Faidherbia albida* were observed at or within close proximity to permanent or semi-permanent settlements. The mean browse range observed near Khowarib, Sesfontein (west of Khowarib), and Ombaadjie (east of the Khowarib) was 1.1m-1.9m.

The greatest influences on mean browse heights were observed at opposite ends of the river course: in the lower Hoanib River (2.4m-2.9m mean browse range) and in the 30km stretch downstream from Kamdescha in the Ombonde River (2.6m-3m mean browse range). The increased mean browse heights corresponded directly with the density and impact of megafuana residing in, or seasonally using the river.

DISCUSSION

Kunene Region (former Kaokoland and Damaraland) - Historical Giraffe

Population Averages

Fluctuations in mammal populations are dependent on a number of biotic and abiotic factors. Precipitation, sex ratios, human disturbances, degree of fragmented environment, predation, nutrient and mineral resource availability are all factors which can limit densities and population dynamics in any given environment. Previous studies of giraffe throughout Africa have been relatively limited, with the majority of data available only for East African parks and the greater Masai ecosystem (Innis, 1953; Foster and Dagg, 1972; Leuthold, 1979; van der Jeugd and Prins, 2000).

In Nairobi National Park, an increase from 100 to 122 individuals was reported over a three year period (Bourliere, 1963 in Foster and Dagg, 1972; Foster, 1966). Three years later only 86 individuals were reported to be residing in the park; a reduction of 30% (Foster and Dagg, 1972). The results may have been skewed by the studies not being focussed on all the various vegetation types in the Nairobi National Park.

Over the past two decades, published data and records of giraffe indicate stable herd sizes throughout the Kunene Region (former Kaokoland and Damaraland). Recent history shows that the average herd sizes in the Kunene Region (1999 and 2000) are slightly higher today than they were on average for the past two decades ago (4.3 versus 3.7 giraffe per herd, respectively) (see Fig. 6). However, the actual numbers of giraffe for the Kunene Region (see Table 1) have varied significantly throughout the last century. More recently, an increase of approximately 100% was observed in 1999-2000 (548 to 1050 individuals).

There were several recent historical survey periods (1983, 1988 and 1995) where the averages observed were in excess of 4 giraffe per herd, but at no time did the averages fall below 3 per herd. This is an indication of a strong herd system amongst giraffe. A slight reduction in the herd numbers reported during these periods can possibly be attributed to the limited surveys and varied surveying quality of previous researchers. Elephant poaching incidences such as those reported by Viljoen (1987, 1988) in the 1980s, was not the only illicit hunting occurring at the time as

giraffe also fell victim, subsequently reducing their average herd sizes (Muzuma and Tjizembisa pers.comm.). This may have been an effect of the giraffe loose social structure.

It is unknown during which seasons these historical surveys were undertaken, and thus they cannot provide any comparative data on herd sizes. As observed in other studies throughout Africa (Innis, 1953; Foster, 1966; Foster and Dagg, 1972; Leuthold, 1979; Le Pendu *et al.*, 2000; van der Jeugd and Prins, 2000), seasonal fluctuations in population density, movement and association between sexes. The seasonal fluctuations of giraffe in the Hoanib River's populations, observed during this study (see Tables 4, 5, 6, 7, 8 and 9), are important in helping to establish densities and usage of the areas. Variation in giraffe estimates and use does occur in the study areas as giraffe periodically and seasonally move out of the river in search of available browse on the plains. However, this aspect of giraffe behaviour was not investigated during this study.

SECTION III

Hoanib River Catchment - Giraffe Populations

Historical Data

Viljoen's (1982a and 1982b) incidental work on giraffe, while undertaking PhD fieldwork on the desert-dwelling elephant in the same environment, estimated a population of 29 giraffe residing in the lower Hoanib River. Following Viljoen's studies, Scheepers (1992) was the only other to undertake a comprehensive research. His findings of a maximum of 35 giraffe residing in the lower Hoanib River indicates a small and stable population. Furthermore, Scheepers (1992) added that there may have been a high calf mortality rate (though not observed) and/or emigration out of the river to areas in the south east. This was supported by two ear-tagged bulls found 50km south of the study area, 18 months after initially being tagged in the lower Hoanib River.

MET surveys in 1980s through early 1990s were often conducted quarterly, sometimes monthly, while other research undertaken were not giraffe specific. Therefore, the quality of surveying and comparative data available is neither concise nor complete.

The impact of hunting in the former Kaokoveld during the 1980s has been reported in the literature (Viljoen, 1987 and 1988; Owen-Smith, 1970), as well as verbally by the people of the north-west (Muzuma and Tjizembisa pers. comm.). Elephant, as opposed to other wildlife, were reported to have suffered the most significant losses from the poachers and the South African Defence Force (SADF) in the north-west (Viljoen, 1988; Owen-Smith pers. comm.). Although giraffe population decline directly due to hunting has not previously been reported, the pressure of hunting activities of all wildlife would have caused unnecessary stress on the giraffe populations.

The exceptional rainfall season that the north-west experienced in 1999/2000 far exceeded the historical mean (MWTC, 1999/2000; Leggett *et al.*, 2001b). This may have contributed to more individuals using the river in the drier periods, as *Faidherbia albida* pod production increased.

Current Data

Current estimates of giraffe throughout the three study areas in the Hoanib River catchment were unfortunately not continuous or linear, and therefore the inference of population growth, decline or stabilisation was based on limited data.

An increase in the number of different giraffe using the lower Hoanib River was observed between 1999 and 2000, 29 to 38 individuals respectively (Table 4). Unfortunately these results are not indicative of the average usage by giraffe in the lower Hoanib River, but represent an estimated number of individuals observed at any one time in the river. This slight increase in population may be attributed to the limited food availability in and outside of the lower river course or the population numbers may be reaching saturation levels.

The mean rainfall of the Ombede River area is markedly higher than that of the lower Hoanib River (MWTC, 1999/2000; Leggett *et al.*, 2001b). The vegetation available to giraffe and other wildlife outside the riparian forest are also more abundant. This abundance and variety of vegetation in the eastern section e.g. *Acacia spp.*, *Commiphora spp.* and *Terminalia prunoides*, lends itself to extended movements by animals outside the river course. Furthermore, these movements correlate with rainfall and availability of free-water in the veld, especially in exceptional seasons (Leggett *et al.*, 2001a). Although giraffe are not dependent on water (Foster and Dagg, 1972), it has been observed that giraffe in the eastern section of the catchment do drink when water is available, as found in Hobatere GP and as indicated by spoor at wetlands in the Khowarib Schlucht. Therefore, the giraffe in the eastern section of the catchment need not be as dependent year round upon the riparian environment as the western population. Throughout the drier periods of the year, the giraffe appear to rely heavily on the river and the availability of forage (see Table 5).

The slight decline in numbers of giraffe in Hobatere GP observed for 2000 may be attributed to the above average mean rainfall for the 1999/2000 season (Leggett *et al.*, 2001b). Giraffe have the ability to move in and out of the park's western boundary, and this immigration and emigration is based around seasonal movements and food availability (van der Jeugd and Prins, 2000). Concerns have been expressed about the impact of increasing numbers of wildlife on both the vegetation and water resources of the Hobatere GP. The elephant moving in and out of the park has damaged large sections of the fence and this assists the movement of other wildlife.

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This movement of wildlife, however, may help relieve grazing and browsing pressure within the park, as animals move to more abundant vegetation resources in the west (VinjevoId and Braine pers.comm.).

Herd Size and Structure

Throughout Africa, giraffe herd relationships have been well reported, with the parental bond described as very 'loose' (Innis, 1953; Foster, 1966; Estes, 1995; Le Pendu *et al.*, 2000). New-born giraffe calves have been reported to spend time with a number of different giraffe herds, while month old calves have been observed to live alone for up to a week at a time before re-joining their respective herds (Innis, 1953; Foster, 1966; Estes, 1995). Adult herds, however, have fewer structures compared to that of parental (cow-calf) herds, with mature bulls rarely associated at all, except during mating periods.

Pratt and Anderson (1982) reported that the giraffe of Arusha National Park, Tanzania, were "strongly segregated into sub-populations with very little exchange (which has) not (been) reported in any other giraffe study". This result may be similar to the dynamics of the giraffe in the far west of their range in north-west Namibia, including the lower Hoanib River, though further analysis is required. Isolated in the lower reaches of the Hoanib and other ephemeral rivers in the north-west (the Hoarusib, Khumib, Ugab and Springbok Rivers), the giraffe seem to have very little north-south movement and in turn, genetic exchange. Hoanib River, though further analysis is required. Isolated in the lower reaches of the Hoanib and other ephemeral rivers in the north-west (the Hoarusib, Khumib, Ugab and Springbok Rivers), the giraffe seem to have very little north-south movement and in turn, genetic exchange.

No evidence of a correlation between herd sizes and seasonal congregation or aggregation was observed in the lower Hoanib River. However, September 1999 and 2000 (hot-dry season) indicated a slightly higher number of individuals per herd, and it can be assumed that the use of the river is year-round, rather than seasonal. Scheepers (1992) supported the lack of seasonal difference in use as well as correlation between herd sizes and seasons postulating that only slight increases (aggregations) in herd numbers were observed during the wet and hot-dry seasons.

The herd sizes observed in the Ombonde River contrasted to that of the lower Hoanib River, where giraffe were observed on every survey, an indication of reliance by giraffe on this riparian forest. The majority of herds were observed during the hot-dry season, which also correlated with the fruiting season of *Faidherbia albida*. The reliance of giraffe, and other wildlife, on the riparian forests of the ephemeral rivers has been previously reported (Viljoen, 1987; Viljoen and Bothma, 1990; Jacobson *et al.*, 1995; Jacobson and Jacobson, 1998). During both the wet and

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cold-dry seasons, few or no herds were observed in the river, as the available resources outside the river course and in the greater Ombonde/Serengeti area were abundant.

Larger herd sizes and more individuals were observed in Hobatere GP, an area that appears to act as a population growth-point for giraffe and other wildlife. Seasonal migration of giraffe from Hobatere GP and the surrounding communal areas increases the use of vegetation on the hills outside the park, thus relieving pressure on vegetation within. No distinctive seasonal fluctuations were observed (with a slight exception for the wet season), though data was limited. The onset and duration of the wet season observed increased herd sizes and densities of giraffe in Hobatere GP. The larger herd sizes observed may be attributed to a seasonal aggregation of herds following rains (as has been observed elsewhere in Africa e.g. Serengeti-Masai Mara), but the relative safety of the park may also lend itself to larger herds.

Innis (1953) reported that single males were observed to be three times more predominant than any other herd combination, while Le Pendu *et al.* 2000 reported 75% of solitary individuals were males. Scheepers (1992) reported that solitary bulls in the lower Hoanib River were the most frequent lone individuals observed, especially during the cold-dry and wet seasons.

Throughout all study areas, solitary herds (predominantly males) accounted for 26% to 38% of the populations. Herd sizes of 2-3 giraffe constituted the seasonally most numerous herds observed. The seasonal variation in herd sizes may be attributed to the availability of resources (Le Pendu *et al.*, 2000) throughout the catchment (Innis, 1953; Foster and Dagg, 1972; Leuthold, 1979; Le Pendu *et al.*, 2000; van der Jeugd and Prins, 2000).

The population structure of giraffe in the lower Hoanib River and Hobatere GP was observed to have a greater percentage of females compared to males. However, the Ombonde River indicated the reverse trend, though due to the large flight distances of giraffe in this area, sex identification was low. The observed skewed sex ratios in all three-study areas can be related to a high degree of giraffe migration (Foster and Dagg, 1972; Scheepers, 1992). Foster and Dagg (1972) in Nairobi National Park and Le Pendu *et al.* (2000) in Niger observed similar dominant adult female numbers, while the population structures observed in the other two study areas (lower Hoanib River and Hobatere GP) correlates to that reported elsewhere in Africa.

Studies on calving seasons of giraffe have reported varying results, however, giraffe appear to breed throughout the year (Foster and Dagg, 1972; Hall-Martin *et al.*, 1975; van der Jeugd and Prins, 2000; Le Pendu *et al.*, 2000). Seasonal breeding peak periods throughout the year were reported by several authors (Ansell, 1960; Foster and Dagg, 1972; Hall-Martin *et al.*, 1975; Smither and Skinner, 1990) and in numerous studies, however, no significant correlation between wet or dry seasons and calving can be inferred. Some studies (Ansell, 1960; Foster and Dagg, 1972) reported no definite calving season with limited evidence available due to low calving percentages. Scheepers (1992) observed a calving peak in the lower Hoanib River population during the wet season, with conception in the hot-dry season when vegetation is abundant, indicating opportunism by giraffe in this arid environment. Joubert and Mostert (1975) reported a calving percentage of 24% throughout Namibia, while Viljoen (1982a) reported that the calving rate in the north-west was 9.3%. Scheepers (1992) reported that over an 11 year period between his and Viljoen's work the growth rate was 1.6% annually, relatively stable. Though the calving rate was 3% over the study period. Since 1992, the growth rate for the lower Hoanib River over the past 8 years has reduced to 1% annually.

Throughout the study areas no new offspring were observed, but a higher percentage of juveniles were observed in Hobatere GP. Several authors (Skinner, 1973 in Hall-Martin *et al.*, 1975; Hall-Martin *et al.*, 1975) reported that African ungulates tend to breed during the most favourable times of the year to coincide with optimal conditions (e.g. available food and water), therefore increasing calf survival. In Namibia's north-west, Scheepers (1992) extrapolated calving dates to coincide with peak periods of vegetation availability during conception dates.

High calf mortality rates have been reported across most study areas in Africa – up to 73% in the Nairobi National Park (Foster and Dagg, 1972). The low recruitment observed throughout this study is most likely to be an indicator of the availability of resources. Both giraffe and elephant depend on *Faidherbia albida* during the dry season. The browse heights of the *Faidherbia albida* indicate the number of wildlife feeding on the vegetation have reached saturation levels. The height observed was 6m above ground level, which is the maximum height at which giraffe and elephant can feed at (Jacobson and Jacobson, 1998; Fennessy *et al.*, 2001; Leggett *et al.*, 2001c).

Population Density – Hoanib River catchment and other areas in Africa

Giraffe densities vary across different habitats and ecosystems. The deserts of Baragoi and Tsavo National Park in Kenya, both support small densities of giraffe (0.01 and 0.2-0.3 per km², respectively) (see Table 11.1), while the temperate Arusha National Park, Tanzania, was observed to have a relatively high density, 3.96 per km² (Stewart and Zaphiro, 1963; Foster and Dagg, 1972; Leuthold, 1979; Pratt and Anderson, 1982). Van der Jeugd and Prins (2000) and Le Pendu *et al.* (2000) reported that the highest densities, smaller home ranges, stable groups and low mobility correlated with the most vegetated areas.

This study observed higher densities of giraffe in most of the study areas and across the seasons when compared to other areas in Africa. The only exception was the Ombonde River in the wet and cold-dry seasons. Precipitation in the form of fog and dew enables giraffe to obtain their moisture content from leaves in the early hours of the morning (Foster and Dagg, 1972; Mills and Hes, 1997). Giraffe in the lower Hoanib do have the ability to seek available food resources away from the river course, although they are predominantly limited to the riverbeds. Movement has been observed along the Hoanib's tributaries to the north and south and males observed venturing further afield than females (Viljoen, 1980, 1982a and b; Scheepers, 1992).

The densities of giraffe observed in the Ombonde River, outside of October and November, were relatively low in comparison to the two other study areas. The importance of this environment during the wet and cold-dry seasons is minimal and the river is assumed to act as a base from where giraffe venture, in search of available food resources. However, during the hot-dry season densities in the river increased approximately six-fold, from 0.59 to 3.62 giraffe/km², cold-dry to hot-dry season respectively. This can be attributed to the importance of the Ombonde River during the hot-dry season, for both giraffe and other wildlife.

Hobatere GP observed the highest densities of giraffe throughout the year, ranging from 2.09/km² (cold-dry) and 2.52/km² (hot-dry) to 3.6 giraffe/km² (wet season). The population in Hobatere GP is not closed, but migration into the hills occurs seasonally, impact being the higher densities in the wet season contrasting with the other two study areas. As the browse availability is greatest on the plains after the rain, giraffe seem to congregate and feed on the new leaves of the *Acacia* and *Combretum* (Hall-Martin, 1974; Hall-Martin *et al.*, 1975; Pellew, 1984; Vinjevold

and Braine pers. comm.). Following the wet season, the giraffe begin to disperse into the hills of the park, and slowly return to the park during the hot-dry season.

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Flight Behaviour

The impacts of tourism, poaching and human development on giraffe and other wildlife, and on their natural environments, has been reported by numerous authors (Babich, 1964; Tinley, 1971; Le Pendu *et al.*, 2000; Warnken and Buckley, 2000). Flight, a reaction of wildlife to unfamiliar circumstances (e.g. predators or disturbance), can help provide an understanding of how habituated to tourism a population may be.

Tourists in the Kruger N.P. have been reported to commit one or more minor offences during their visit to the park (Babich, 1964). The disturbances ranged from loud noises to speeding and alighting from their vehicles. Throughout the Hoanib River catchment (with the exception of concession areas such as Hobatere GP), tourism is largely uncontrolled. Scheepers' (1992) brief assessment of flight behaviour in the lower Hoanib River reported that due to an increase in tourism in the 1980s, giraffe flight distances decreased due to habituation to tourist vehicles (157m (1986) to 114m (1988)). Furthermore he observed a correlation between wind and flight ($P = <0.05$). This was not observed during this study.

During the study, the smallest giraffe flight disturbance behaviour was observed in the lower Hoanib River. The giraffe in this section of the river have been subjected to tourism and research since the mid- to late seventies (though increasing in the 1980s) when the Kaokoveld was open to tourism. This habituation to tourists for the past couple of decades has posed a minimal disturbance impact on the population, though potential physiological costs (i.e. heat exhaustion from flight) may occur. In the past five years, the numbers of tourists visiting the area has increased significantly with a number of tourist-wildlife incidents being reported e.g. elephants circled by motor bikes or chasing of elephants for photographic reasons (SRT pers.comm.; MacGregor pers.comm.). With escalating numbers of tourists entering the lower Hoanib River, and no control measures, the impact on wildlife and the natural environment is unknown.

The giraffe in the Ombonde River were observed to have a far larger flight distance than those in either of the two other study areas – ranging from category 3 to 5 (>25m). Historically, local hunters have sought giraffe in this eastern section of the catchment, for meat and hide (Muzuma and Tjizembisa pers. comm.). More recently, the hunting has been curbed significantly, as conservancies and conservation ethics have developed (MET, 1995; MET, 1997). Increased numbers of people, and as a result, increased numbers of livestock, in the north-west, have

created more pressure on the land, and therefore competition for available resources. Giraffe prefer to live in areas away from human influences and this impact is placing greater pressure on their former range and reproduction potential. The skittish behaviour of the giraffe in the Ombonde River is natural, given the historical intolerance for wildlife in the north-west.

Hobatere GP's giraffe population indicated flight behaviour patterns that were different to the two other study areas. This observation may be attributed to the park being semi-confined, with immigration and emigration of individuals. Furthermore, Hobatere GP was previously a hunting concession. This recent hunting and culling history would still be vivid in the memory of all mature animals. During the study period a disturbance impact was observed following a zebra (*Equus zebra hartmannae*) cull (Fox, Loutit, Braine and Vinjevold pers.comm.). During the giraffe ground survey in August 2000, the disturbance of giraffe caused by a zebra cull in April 1999, seemed greater than during any previous survey. Most animals showed a high degree of disturbance, especially in the southern area of the park where few (if any) game drives are normally undertaken. Few giraffe were observed in the area in which the cull was focussed. In other sections of the park, giraffe behaviour was also flighty and could be attributed to the culling that had occurred months earlier.

Giraffe Mortalities – Natural Senescence and Predation

According to Foster and Dagg (1972), mortalities of giraffe throughout Africa are highest in the first year of life, and in particular the first month or two. Predation by lions and leopards, and possibly hyena and crocodile, have been indicated as possible causes of juvenile deaths throughout areas of Africa (Foster and Dagg, 1972). However, in the north-west of Namibia, reduced lion and hyena populations, and a lack of crocodile, limits this impact. Foster and Dagg (1972) further concluded that only one fifth of all giraffe reach sexual maturity. Throughout recent history, disease has resulted in the decimation of numerous wild species. Throughout Etosha NP and the north-west, anthrax has been regarded as an existing threat requiring control measures. During the early 1990s, a number of elephant were vaccinated against anthrax in the north-west after anthrax was found to be the cause of one elephant death near the Dubis wetland, lower Hoanib River (Loutit pers.comm.).

During the period 1963-1990, only 18 cases of anthrax related giraffe deaths (confirmed or suspected) were observed in the Etosha N.P (Berry, 1997). These giraffe deaths accounted for only 0.6% of the total anthrax deaths recorded in the Park for the same period (Berry, 1997).

The severe drought of 1982 which resulted in large scale losses of livestock and plains game (kudu (*Tragelephus stesiceros*), gemsbok (*Oryx gazella*), springbok (*Antidorcas marsupialis*) and zebra) in the north-west, seemingly did not have an effect on the giraffe population with no mortalities observed (Scheepers, 1992). This is a good example of the adaptation of giraffe (e.g. feeding habits or movement) within this arid environment.

Scheepers (1992) reported three mortalities in the lower Hoanib during his research period – one, a three year-old calf, from predation by lions and the other two from natural senescence. The lion pride, which predominantly feed upon the springbok, gemsbok and ostrich (*Struthio camelus*) in the river, were later shot as problem animal control. This was the last pride to frequent the lower Hoanib River.

Throughout this study only eight mortalities were observed (see Appendix B for details). None of the mortalities observed in the catchment were attributed to anthrax or drought, but rather as a result of natural senescence, predation and the impact of fences. With increasing population range, including predators, lions may be once again play a role in the mortality rates of giraffe

and other wildlife in the north-west (Stander and Hansen, 2000). The impact of fences has been well documented in other areas of Africa (i.e. Botswana and wildebeest migration) and it is important that, with increasing fencing in communal land, appropriate monitoring of impact be undertaken.

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Browse

Giraffe have been reported to directly influence vegetation structure and densities in some parks throughout Africa (Foster and Dagg, 1972; Leuthold, 1979). Evolutionary adaptations of typical savannah species have resulted in protection mechanisms such as thorns or spines. The *Acacia*'s of Australia have no thorns, which can be seen as an adaptation of the African species to heavy browsing (Foster and Dagg, 1972).

A significant correlation was observed in relation to *Faidherbia albida* browse heights and wildlife densities in the lower Hoanib and Ombonde Rivers (Nott, 1987; Viljoen and Bothma, 1990; Jacobson and Jacobson, 1998; Fennessy *et al.*, 2001; Leggett *et al.*, 2001a). Both ends of the river course observed high mean browse heights, indicating a high consumption of *Faidherbia albida* by giraffe and elephants in this area.

Approximately 80% of all browse heights in the lower Hoanib River were observed to be higher than 3m. A significant percentage (approx. 50%) of browse heights higher than 3m were observed in the Ombonde River, in particular the eastern reaches, where seasonal and resident populations of both giraffe and elephant occur. In the western reaches of the river (Dubis to Khowarib) low browse heights were observed and no giraffe seasonally frequented this area. This directly correlates with areas predominantly populated by domestic stock, close to permanent or seasonal dwellings. Competition between domestic stock and wildlife has resulted in stretches of the river being under-used by wildlife.

The browse heights of *Faidherbia albida* in the lower Hoanib and Ombonde Rivers are possibly at saturation levels. The amount of available browse is limited because of competition between giraffe and elephant. As populations increase for all species so too does the need for a greater food base. Elephant have the added ability to shake off *Faidherbia albida* pods, break branches and stems which helps provide them with greater amounts of vegetation. This influence by elephant is the greatest on *Faidherbia albida* in the Hoanib River and maybe detrimental to the future of giraffe (Laws, 1970; Nott, 1987; Viljoen and Bothma, 1990; Jacobson and Jacobson, 1998).

Recruitment of *Faidherbia albida* is limited due to the feeding behavior of animals in the Hoanib River. Wildlife (especially giraffe, elephants and gemsbok) and domestic stock prefer to feed on young *Faidherbia albida* seedlings and coppices. This concept has been well reported throughout

Africa, and similar impacts were observed throughout the entire Hoanib River (CTFT, 1989; Jacobson and Jacobson, 1998).

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Drinking Behaviour

Throughout Africa, giraffe have been reported to survive for months without drinking, or possibly even exist indefinitely without any water source (Taylor, 1968; Foster and Dagg, 1972). This lack of free-water dependency may be attributed to the moisture-rich browse, on which the giraffe feed (Taylor, 1968; Wyatt in Foster and Dagg, 1972; and Hall Martin and Basson, 1975; Mills and Hes, 1997).

Due to a higher mean rainfall in the eastern section of the catchment, a greater amount of free-water is available in the veld compared to those areas in the lower catchment. Available and reliable sources of free-water in Hobatere GP have provided giraffe with a greater availability to drink. However, observations of them doing so have not occurred.

The only available water in the Ombonde River is in the Khowarib Schlucht in the far eastern section. Human settlements at the Khowarib Schlucht and Ombaadjie are located close to these wetlands. However, giraffe spore in the Khowarib Schlucht was observed on several occasions though this was thought to be a rare event.

On the other hand, desert-dwelling giraffe are renowned for their lack of drinking, with only a few known observations (all solitary bulls with the exception of this studies observation) in the lower Hoanib River in the last 70 years (Viljoen, 1980; Scheepers, 1992; Colbeck, 1999; Owen-Smith pers.comm.).

The single observation of a giraffe bull drinking in the lower Hoanib River was rare and shed little light on this phenomenon (see Appendix C for details). Little rainfall occurs in the extreme west and precipitation in the form of fog and dew accounts for approximately twice as much moisture than rainfall, and a third of the variability (Southgate *et al.*, 1996). The giraffe perceive to obtain the majority of, if not all, their moisture requirements from their food source and, therefore this sighting was extremely rare.

The 'norm' for giraffe in the north-west Namibia is that of an adaptation to survival without free water. However, this lack of water limits their movement and resident times away from the ephemeral river courses.

CONCLUSION

Healthy populations of giraffe have existed throughout Kaokoland for the last century, and recent history indicates that increasing numbers have been observed throughout both the Hoanib River catchment, as well as the Kunene Region. High densities of giraffe were observed across all study areas though the 'semi-confined' Hobatere GP showed large year-round densities.

The observed flight behaviour across the study areas is markedly varied. The greatest flight disturbances were observed in the Ombonde River, an area with minimal tourism compared to the other study sites, though frequent local human movement occurs.

A distinct shift in the limited browse availability of *Faidherbia albida* available to smaller wildlife was observed along the river. This impact was predominantly due to giraffe and elephant influences, thus the question of whether browse availability is reaching saturation levels is pertinent.

Little mortality was observed throughout the study period, though figures may be higher than observed because of limited access to other areas in the catchment. However, water was found not to be the limiting factors in giraffe survival, even though opportunistic drinking bouts were recorded.

In conclusion, the study showed that further research into the ecology of desert-dwelling giraffe needs to be undertaken and the recommendations presented can help to form the basis of any future studies.

MANAGEMENT IMPLICATIONS

1. A distinct lack of data is apparent on the desert-dwelling giraffe and it is imperative that with increased research, adequate focal studies and monitoring be undertaken e.g. physiological adaptations of giraffe in this arid environment.
2. The questions arising from the observed seasonal densities in the catchment are: What is the maximum carrying capacity of giraffe and other wildlife in these environments? How sustainable are the present giraffe densities, especially with respect to other areas in Africa? What will be the short-term and long-term impact on the riparian vegetation?
3. Global positioning system (GPS) collars would be essential in understanding home ranges and seasonal movements of desert-dwelling giraffe in the north-west. Radio tracking and ground monitoring would be beneficial, however, it is limiting because of the undulating geographic and climatic conditions.
4. With the development of emerging and established conservancies playing a larger role in the conservation of habitat and wildlife in the north-west, appropriate Community Based Natural Resource Management (CBNRM) is required. An increase in conservation efforts should provide greater local community understanding and further strengthen the likelihood of both survival and prosperity of giraffe.
5. Finally, if the planned inclusion of Hobatere GP within the #Khaodi-//Hoas conservancy comes to fruition, the profits obtained from sales of live giraffe or meat from culling would allow for a better working relationship between the concessionaires and the conservancy.

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APPENDIX B

GIRAFFE MORTALITIES

SECTION III

1st Mortality:

The first recorded mortality of giraffe during the research was that of a Class VI 'Black' Bull, in the Ombonde River, October 1998 (Leggett and Bakkes pers.comm.). Unfortunately, no samples were taken or tests conducted as to the cause of its death. The visual inspection failed to reveal any cause of death, but predator attack was ruled out since no predator spoor was observed and the carcass was intact (not fed upon). Therefore, as it was an old bull, it was assumed that the animal died of natural causes, with the dry period of late 1998 maybe playing a minor contributing factor.

2nd Mortality:

A giraffe bull Class IV was found on the western fence line of Hobatere GP in September 1999. The animal had died a month or two earlier and after personal communications with Vinjevold and Braine (1999), the approximate time of death was confirmed. The cause of death was most likely starvation, as the immature bull had become entangled in the fence line and was unable to pull free. The manner in which it become entangled is unknown, though it was likely attempting to leave the confines of the park, seeking greener pastures in the hills to the west. A possible cause of death was that the giraffe was attempting to flee from a predator, as observed for two other mortalities in the park. However, no signs of predator spoor or mutilation of the carcass were observed.

3rd Mortality:

An old 'Black' Bull Class VI was found dead three kilometres west (inside) of the Skeleton Coast Park boundary, lower Hoanib River (Gilchrist pers.comm.). When found, a quick visual examination was undertaken and it was decided that swab and skin samples be taken for further analysis at the Ministry of Agriculture, Water and Rural Development (MAWRD) – Central Veterinary Laboratory (Windhoek). The results of the samples returned negative and anthrax was ruled out as the cause (MAWRD, 1999). It was estimated that the age of the individual (as per its size, colour and worn dentition), combined with the very arid conditions of the lower Hoanib River in late 1999, culminated in the animal's natural death.

4th and 5th Mortalities:

The concessionaire and manager of Hobatere GP found two giraffe mortalities – unknown sex and class IV-V, during the hot-dry season of 1999 (Vinjevold and Braine pers comm.). Due to

the age of the carcasses the cause of death was unknown but both were assumed to have died of natural senescence.

6th Mortality:

Although not a regular occurrence, with little literature found, leopard (*Panthera pardus*) predation of giraffe has previously been recorded within Namibia, though more commonly reported in East Africa (Foster and Dagg, 1972; Scheepers and Gilchrist, 1991). Predation on giraffe calves by both lions (*Panthera leo*) and leopards has been recorded in both the western section of Etosha N.P. and the Skeleton Coast Park (Scheepers and Gilchrist, 1991; Paterson J. and Kilian pers.comm.).

With the continual persecution of lion by communal farmers over the former Kaokoland and Damaraland, in particular the last 20-30 years, the predatory role they may have previously had on giraffe and other wildlife populations is now unknown. Though numbers of lion and their range are now recorded to be increasing in the north-western regions, conflict with human populations and their livestock will seemingly result in their restrictive range (Vinjevoold pers.comm.; Stander and Hanssen, 2000). No recent observations of lion kills of giraffe have been recorded west of Etosha NP, predominantly due to the shyness of lion and the limited accessibility of researchers into such a vast area. However, reports of lion kills of domestic stock and small herbivores in the communal areas of the north-west have been reported (McClure and IRDNC pers.comm.).

Leopards, however, mostly attributed to their elusiveness, have maintained a remarkably healthy population within this and surrounding catchments (McClure pers.comm.; Stander and Hanssen, 2000). A short note published by Scheepers and Gilchrist (1991) reported on two cases of leopard predation of giraffe calves in the west of Etosha N.P. Though brief, Scheepers and Gilchrist detailed the approximate age and weight of the calves that were preyed upon, which seemingly had not been previously recorded.

7th Mortality:

In 1999 Vinjevoold (pers.comm.) observed a new-born giraffe calf, Class I, in Hobatere GP which only a couple of days after birth was no longer seen with its mother. After searching the surrounding area, the calf was found dead and the spore around the carcass, which had been fed

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upon, was that of a leopard. Vinjevold further stated that numerous leopards existed in the park though the exact numbers and their impact was unknown.

During 1999/2000 the Namibian Carnivore Monitoring Program (NCMP), under the auspices of Dr Stander, began more intensive research efforts in the Otjovasandu basin area i.e. Hobatere GP and far western Etosha NP. This research was undertaken in an attempt to better understand carnivore behaviour in the area – lion, leopard, spotted hyena (*Crocuta crocuta*) and brown hyena (*Hyaena brunnea*).

8th Mortality:

McClure (pers.comm.), as a researcher with the NCMP, with the assistance of Khoi trackers, tracked a leopard kill of a male giraffe calf, Class II, in the Hobatere GP, July 2000. The trackers had retraced the events of the kill and concluded that a leopard had definitely preyed upon the giraffe. The nature of the Hobatere GP environment limits the surveying capabilities, as it is undulating and hilly. Therefore, other predatory behaviour may have occurred but is unknown. Continued research will hopefully find a few answers to predator density and predator-prey relationships.

APPENDIX C

GIRAFFE DRINKING OBSERVATION

SECTION III

The following is the first known annotated observation of a giraffe drinking in the lower Hoanib River, north-west Namibia:

On Monday 13th November, 2000, at 13.20 hrs, a mature giraffe bull was observed splaying its fore legs and bending forward over a 'gorras' (Damara word for digging or hole) at the third Dubis wetland (S -19.22356, E 13.41056), lower Hoanib River. When approached, the giraffe immediately stood upright and turned in the direction of the vehicle. After approximately three minutes the giraffe again splayed its fore legs, leant forward and once more drank from the 'gorras'. It proceeded taking two more bouts of drinking before slowly moving off up river, easterly direction, and joining up with another giraffe bull.

Each drinking bout lasted between 0.5-2 minutes with small time intervals between each. After the giraffe moved far enough away from the 'gorras', the drinking hole was examined. The 'gorras' and others in the immediate vicinity contained water seeping from into the sand river. Spore of this and possibly other giraffe that had been drinking was observed at definitely one, possibly two other 'gorras'. Unfortunately, excessive trampling by other wildlife had occurred around the 'gorras'.

The 'gorras' at which the giraffe drank was very saline (PH 8.79 ± 0.10 , Conductivity (mS^{-1}) 840 ± 4.76 , Total Dissolved Solids (mg/L) 5.33 ± 1.36 and Temperature ($^{\circ}\text{C}$) 29.3 ± 0.99), when compared to the two Dubis wetlands further upstream (east) which were less saline (Leggett et al., 2001d).

The significance of this event is relative to the arid environment. The few tourists who explore this area may not recognise the importance of giraffe drinking, and unfortunately a greater information base is lost. Access to the area is restricted during most of the wet season (January to April) also limiting observations and information on the dependency of giraffe on available water.