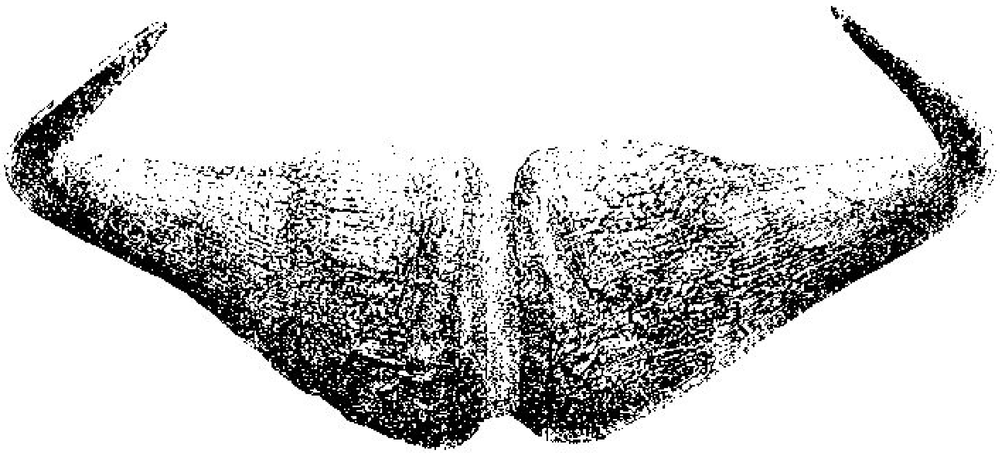
TRANSBOUNDARY SPECIES PROJECT

SOUTHERN SAVANNA BUFFALO



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Species Report for Southern Savanna Buffalo
in support of
The Transboundary Mammal Project
of the
Ministry of Environment and Tourism, Namibia
facilitated by
The Namibia Nature Foundation
and
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Living in a Finite Environment (LIFE) Programme

Cover drawing by Frederick Courteney Selous

of a buffalo trophy taken on the banks of the Ramokwebani River, Botswana, in 1877

A Hunter's Wanderings in Africa

Richard Bentley & Son, London

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1881

CONTENTS

List of Appendices

List of Figures

List of Tables

PREFACE

I have not given a list of acronyms at the start of this report because I have tried to avoid using them in the text and, where one is used, the meaning is given together with the acronym.

The term 'Project Area' is used frequently in the report and refers to that area which includes the buffalo population of northern Namibia and northern Botswana together with the relevant parts of south-eastern Angola, south-western Zambia and north-western Zimbabwe.

In keeping with the terminology of the magnificent Caprivi Atlas of Mendelsohn and Roberts, I have used the word 'Caprivi' throughout the report to refer to the 'peninsular' of land extending eastwards from the north-eastern corner of Namibia and reserved the phrase 'Caprivi Strip' for the narrow 'isthmus' connecting the broader part of the peninsular to the main body of Namibia.

In advance, the author apologises for the length of this report. It is long partly because there is a large amount of available literature on buffalo – most of it relevant to the subject in hand and much of it extremely interesting. It is long also because there was scope in the project to explore and test a number of "what if" scenarios which have produced fascinating results – often not what were expected. It appears longer than it really is because of the large numbers of maps and diagrams intermingled with the text.

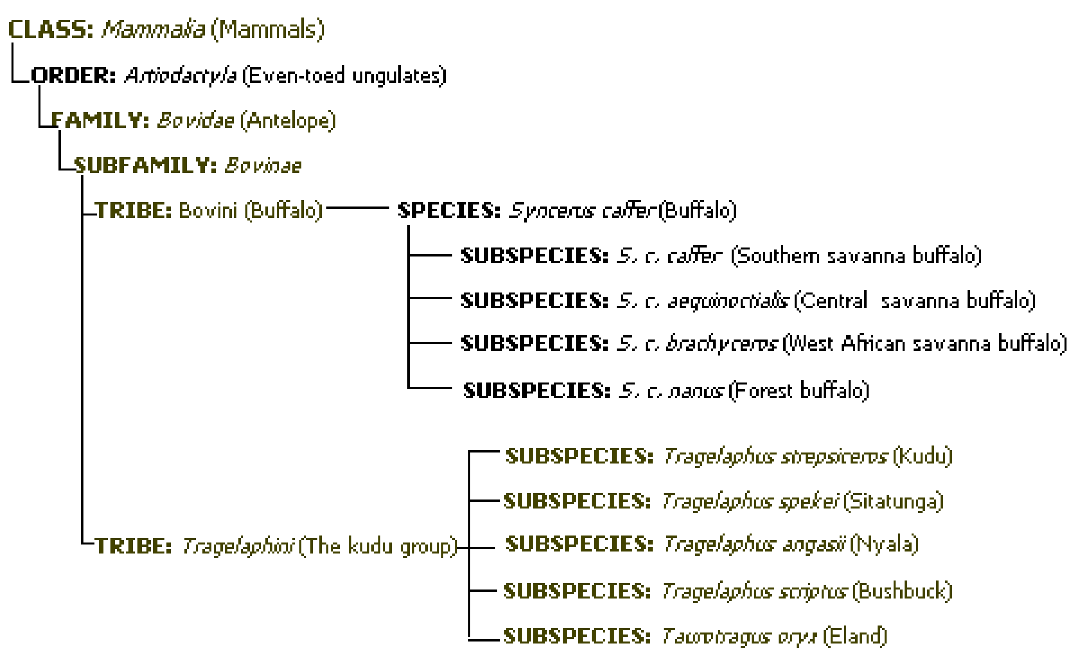
I would like to thank all those people who gave so kindly of their time and valuable experience when I was in Windhoek at the start of this project in early October. In particular, I thank Chris Brown of the Namibia Nature Foundation, Chris Weaver of the WWF LIFE programme and Ben Beytell and Pauline Lindeque of the Ministry of Environment and Tourism. I am unused to receiving such a high level of support and assistance on consulting work and thank Barbara Paterson especially for her full time dedication to arranging meetings and obtaining important documents. For agreeing to meetings at very short notice and providing valuable data at the time and afterwards, I thank Isaac Theophilus, Jan Broekhuis and Dan Maghogho of the Botswana Department of Wildlife and National Parks. Finally, I would like to thank Debbie Gibson for her hospitality whilst staying in Windhoek and both her and Jon Barnes for the supply of key information which has continued during the writing of this report.

1. BIOLOGICAL INFORMATION

a. Taxonomy

All African buffalo are classified in the Subfamily *Bovinae* of the Antelope Family *Bovidae*. Two Tribes are recognised within the *Bovinae*: the *Bovini* tribe which is exclusive to the buffalo *Syncerus caffer* (Sparrman 1779) and the *Tragelaphini* which includes five antelope species of the 'kudu group'. Smithers (1983) notes the controversy surrounding the possibility of subspecies within the taxon and recognises the main race of Savanna buffalo *S.c. caffer* and the Forest buffalo *S.c. nanus* which occurs along the west coast of Africa from Cameroun to the Ivory Coast.

The IUCN/SSC Antelope Specialist Group (ASG 1998a, p106) divides the Savanna buffalo into three subspecies: *S.c. brachyceros* – the West African savanna buffalo; *S.c. aequinoctialis* – the Central African savanna buffalo and ***S.c. caffer*** – **the Southern savanna buffalo**. This terminology will be used throughout the report for consistency with the Antelope Specialist Group. ASG (*ibid*) state unequivocally that "... there is no doubt about the validity of these four subspecies. The three forms of savanna buffalo are at least as distinct from one another as from *S.c. nanus*". The taxonomic classification of buffalo is shown in **Fig.1** below and the map showing the distribution of the four subspecies is shown on the following page (**Fig.2**). The southern savanna buffalo subspecies is by far the most numerous and widely distributed across the continent. The ASG notes that other subspecies (e.g. the "mountain buffalo" *S.c. mathews* of eastern Africa) may be valid but notes that intergrades occur amongst the recognised subspecies.



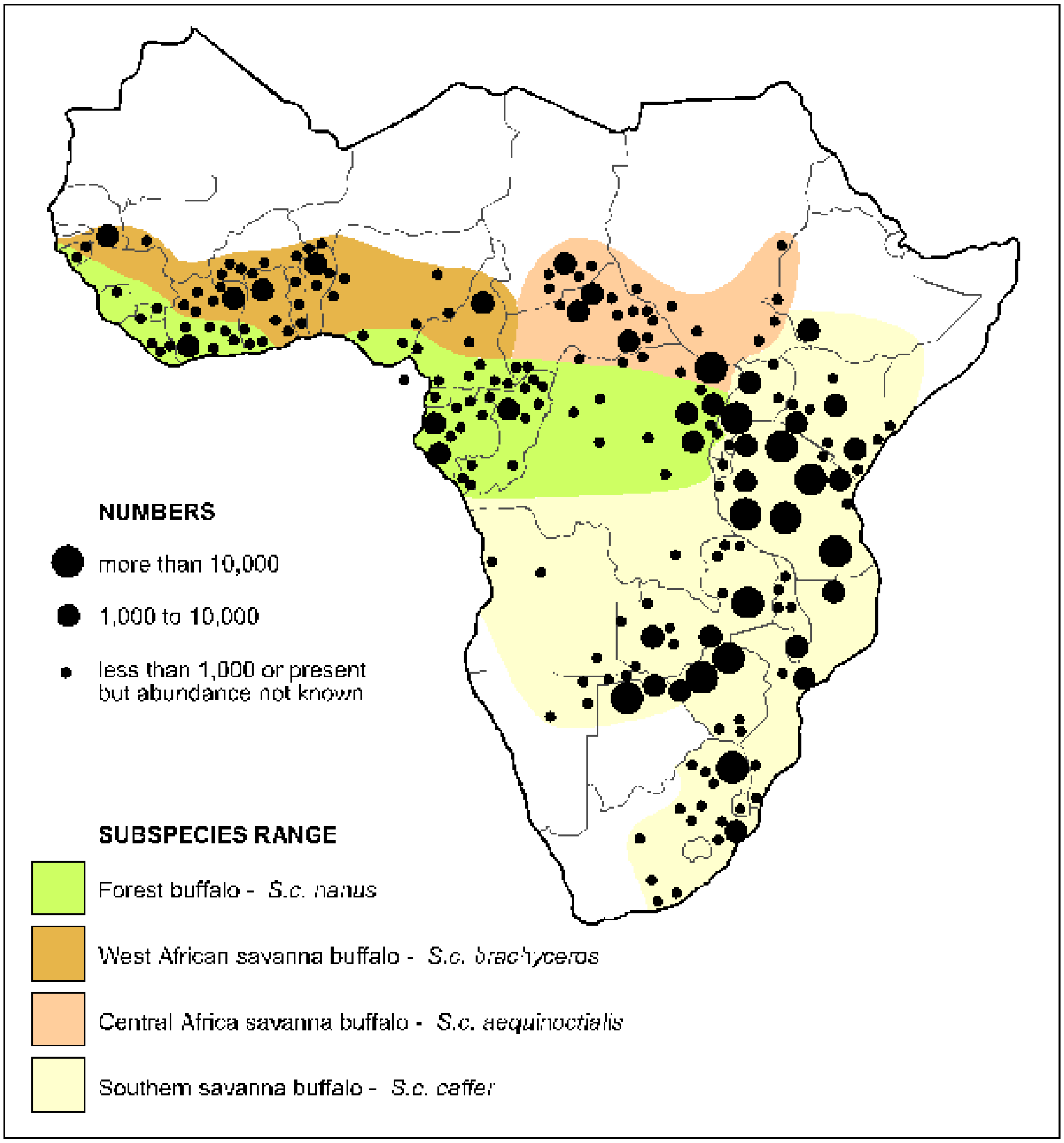


Figure 2: Numbers and Distribution of Buffalo Syncerus caffer in Sub-Saharen Africa.

Source: ASG (1998a)

Georgiadis (*et al* 1990) examined DNA samples taken from buffalo over a wide range of African countries and concluded that, whilst there were considerable differences in genetic composition between the extremes of the range, there were no obvious disjunctions in the genetic samples which might form the basis for assigning subspecies status to buffalo from any particular locality. This has implications for the present herd of buffalo in the Waterberg National Park in Namibia which was introduced from Addo National Park in South Africa: it is unlikely to contain significant or marked genetic variation from the remainder of the subspecies *S.c. caffer*.

b. Physical description

Buffalo are the heaviest species within the Antelope family (*Bovidae*) with males achieving a body weight of up to 800kg and females up to 750kg (Smithers 1983). Taylor (1985, p355) compared asymptotic body weights for four different buffalo populations in Africa and found that they varied little from 700kg for males and 500kg for females. Coe, Cumming and Philipson (1976) used 450kg as the mean individual weight for the average animal in a buffalo population. Typical shoulder heights are 155cm for adult males and 145cm for adult females. The weight of a buffalo calf at birth is about 40kg and males achieve their full adult weight after about 7 years and females after about 5 years.

Apart from their horn shape, the bodily form of buffalo resembles that of cattle. The front hooves are significantly larger than the hind hooves presumably because of the additional weight in the massive forequarters, head and neck. Adult male buffalo are black and females, subadults and juveniles all show a tinge of reddish-brown colouring.

Buffalo are a key animal in the international sport hunting industry and are perhaps the most sought after amongst the "Big Five" species. Buffalo bulls have a reputation for being extremely dangerous, particularly when wounded. There is a dichotomy amongst buffalo hunters in the preferred type of buffalo trophy – many European hunters place the emphasis on old animals with large horn bosses and are less concerned about the size of horns: most American hunters seek the largest horn measurements in order to gain a place in the trophy record books. Smithers (1983) gives the largest trophy record from southern Africa as a buffalo taken in Zimbabwe in 1973 and measuring124.8cm over the outside curve from the centre of the boss to the tip of the horn.[1]

c. Habitat

Buffalo require a year-round supply of grass, adequate water and shade. They occur (or used to occur) in most of the savanna areas of Africa where annual rainfall exceeds 300mm and these requirements can be met. Most woodland types in the southern African region provide suitable habitat, including Mopane, Miombo (*Brachystegia*), Acacia, Teak (*Baikiaea plurijuga*), riparian fringes and vleis (or 'omurambas'). They may be unable to use large open grasslands if there is not adequate shade for resting in the hotter parts of the day or if water is insufficient. Buffalo normally drink twice daily and Pienaar (1969) estimated the daily consumption of water to be slightly more than 30 litres for an average animal.

In Namibia, most of the Caprivi is good habitat for buffalo except where distance to water is a constraint. In the remainder of the country, any area which is capable of supporting cattle would also support buffalo. Carrying capacities would decline towards the arid south and west and, in areas where annual rainfall is less than 250mm , buffalo would be unlikely to survive (Stewart and Stewart 1963). Large parts of the north have held buffalo in the past and could probably carry modest densities today were it not for veterinary policies and practices which preclude this. Given adequate water and rainfall of 300-400 mm/annum, buffalo might achieve densities of the

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1. I personally saw a buffalo trophy taken in Chirisa Safari area in Zimbabwe in 1978 which measured 132cm. It may not have been entered in the record books at the time of Smithers' publication.

order of 1/km^2 or a biomass of about 5kg/ha (Coe, Cumming and Philipson 1976).

A list of grass species eaten by buffalo has been compiled from three major studies and appears in **Table 1** on the following page. A significant proportion of these species occur in Namibia, as indicated in the table. This is by no means a complete list and it is likely that many species which occur in Namibia and which are not on the list would also be acceptable food for buffalo. It is also well documented that buffalo include a small proportion of woody browse plants in their diet during the dry season (e.g. Pienaar (1969) records mopane, *Grewia*, *Dichrostachys*, *Combretum*, *Ozoroa*, *Euclea*, *Diospyros* and *Securinega* spp.).

Taylor (1985) studied the response of buffalo to the grass *Panicum repens* on the shores of Lake Kariba in Zimbabwe where buffalo numbers increased from some 800 animals in 1974 to over 3,000 (a density of 8 buffalo/km^2) in 1983. All of the *Panicum* species recorded by researchers in southern Africa as preferred by buffalo (*P. coloratum, P. maximum, P. repens)* occur in a broad swathe across southern Africa and are present in the northern areas of Namibia.

Buffalo play a key ecological rôle as a bulk grazer. By removing a large overburden of tall grasses, they facilitate access for other large mammals which would normally avoid such habitats and their grazing tends to alter the grass sward which in a manner which favours other grazers. On private ranches in South Africa and Zimbabwe which at one time supported cattle and have since converted exclusively to wildlife, it is very noticeable that the absence of large bulk grazers often results in a rank sward of tall grasses which are avoided by most wildlife species. There is now a major drive by wildlife farmers to acquire buffalo in order to rectify this type of ‘unbalanced’ ecosystem.

In Namibia, the majority of large private farms in the north of the country carry both cattle and wildlife and wildlife tends to be an auxiliary land use which supplements cattle income. This raises the interesting question why such a situation pertains when it is clearly demonstrated by trends elsewhere in southern Africa that wildlife is a more profitable land use than cattle in arid and semi-arid areas. Moreover, the concept that wildlife and cattle may complement one another has been shown to be false (Martin 1989) – cattle detract from the higher-valued land use which is possible with wildlife when large bulk grazers such as buffalo are included in the species mix. The results of Taylor’s (1985, p256) study suggest that buffalo use grazing resources more efficiently than do domestic livestock.

Two explanations, possibly acting in combination, offer themselves for the Namibian situation. Veterinary restrictions preclude the inclusion of buffalo in multi-species management systems on large ranches and, therefore, to preserve the desirable habitats for many wildlife species, cattle play the ecological rôle which buffalo would normally fulfil in ‘natural’ systems. The other contributing factor is that ‘ownership’ systems for cattle in Namibia are absolute – far stronger than those for wildlife. Given full devolution of proprietorship over wildlife, it is possible that wildlife as an exclusive land use would become more prevalent in Namibia.

Table 1: Grass Species in the Diet of Southern Savanna Buffalo

SPECIES	Namibia	SPECIES	Namibia
Andropogon gayanus [2,3]	N	*Heteropogon contortus* [2,3,4]	NC
Aristida rhiniochloa [2]	NC	*Hyparrhenia filipendula* [1,2]	_
Aristida pilgeri [2]	?	*Hyparrhenia rufa* [2]	?
Brachiaria brizantha [4]	N	*Hyparrhenia* spp. [1]	✓
Brachiaria nigropedata [3]	NC	*Hyperthelia dissoluta* [2,3]	N
Brachiaria spp. [2]	✓	*Imperata* spp.[1]	N
Bothriochloa insculpta [3]	N	*Loudetia flavida* [2]	_
Bothriochloa spp.[1]	✓	*Panicum coloratum* [1,3]	A
Cenchrus ciliaris [1,3]	A	*Panicum maximum* [1,3]	A
Chloris gayana [1]	K	*Panicum repens* [1,2]	N
Chloris virgata [2]	A	*Pennisetum clandestinum* [1]	_
Cynodon dactylon [1]	K & W	*Pennisetum mezianum* [1]	?
Cynodon plectostachyus [1]	_	*Phragmitis australis* [3]	NC
Dactylocteneum giganteum [4]	N	*Schmidtia bulbosa* [3]	?
Digitaria diagonalis [2]	K	*Setaria sphacelata* [2,3]	N
Digitaria macrobhlephora [1]	_	*Sorghum bicolor* [3]	NW
Digitaria milanjiana [2]	?	*Sporobolus iocladus* [2]	A
Digitaria spp.[3]	✓	*Sporobolus pyramidalis* [1]	K
Diheteropogon amplectens [2,3]	_	*Sporobolus robustus* [3]	?
Echinochloa stagnina [3]	?	*Sporobolus spicatus* [1]	?
Enneapogon cenchroides [3]	A	*Themeda triandra* [1,3]	N
Eragrostis rigidior [2]	N	*Typha capensis* [3]	?
Eragrostis superba [1,2,3]	NCW	*Urochloa mosambicensis* [4]	K
Eragrostis viscosa [2]	NC	*Uochloa trichopus* [2]	?

References

1. Sinclair, A.R.E. and M.D. Gwynne (1972)
2. Taylor, R.D. (1985)
3. Pienaar, U.de V (1969)
4. Martin, R.B. personal observations
5. van Oudtshoorn, Fritz & Eben van Wyk (1999) (Occurrence of various grass species in Namibia)

Key to Namibia symbols

A - Throughout Namibia
NCW - North, Central and Western Namibia
NC - North and Central Namibia
N - Northern Namibia including Caprivi
K - Caprivi only
✓ - Genus occurs in Namibia
? - Presence of species not known
_ - Species does not occur in Namibia

d. Reproduction and Population Dynamics

The southern savanna buffalo breeds seasonally from January to April in southern Africa with the majority of births occurring in January and February. In East Africa where a double rainy season occurs, the seasonal pattern of breeding is less marked. The gestation period is 330-346 days (Smithers 1983) indicating that in a typical savanna habitat most conceptions take place shortly after the grass sward biomass has peaked in the February of the previous year. The sex ratios within buffalo populations are very close to unity (Pienaar 1969, Taylor 1985). For any large mammal population, the parameters which determine the population growth rate are –

(1) Longevity;

(2) The female breeding lifetime including age at first conception;

(3) Age-specific fecundity;

(4) Age-specific mortality; and

(5) Density dependence.

Each of these parameters is discussed below in some depth because at the end of this section a population model has been constructed to examine the potential rates of growth for buffalo populations in different areas of Namibia.

(1) Longevity Although buffalo in captivity may live as long as 25 years, very few animals in the wild survive to an age of 20 years. Taylor (1985) found no specimens older than 18 years in his Matusadona study and, as the number of animals older than this would form a tiny fraction of the total population, this age has been selected as last age class in the model which follows.

(2) Breeding lifetime The age at first conception for buffalo females is slightly dependent on environmental factors: where the nutrition regime is high, it tends be to be slightly earlier and where food is limiting it may occur later. Female body weight may be a more significant criterion determining the first conception than age: Taylor (1985) found that about 50% of females became pregnant when their body weight reached 350kg – which corresponds roughly to an age of 3.5 years. Taylor (1985, pp312-313) found the following proportions for age at first conception in his study, and I have added the extra row to give the proportions of animals which will give birth a year later. These proportions have been used in the population model.

Age	0-2 years	2-3 years	3-4 years	4-5 years	5-6 years	6 years +
Proportion conceiving	0	10%	32%	79%	100%	–
Proportion giving birth	0	0	10%	32%	79%	100%

Taylor (1985, pp374) found that cows at Matusadona maintained a high level of fertility until the fourteenth year of life but notes that other authors have generally found that fecundity begins to decline after the eleventh year (e.g. Patterson 1979). In the model, a multiplier has been used to adjust the average fecundity for each age class. The results are shown below for an average fecundity of 0.5, i.e. one calf every two years (the average is calculated over the ages 6-16 years) –

AGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Multiplier	0.00	0.00	0.00	0.10	0.32	0.79	1.10	1.20	1.30	1.40	1.30	1.20	1.10	1.00	0.50	0.25	0.00	0.00
Fecundity	0.00	0.00	0.00	0.05	0.16	0.40	0.55	0.60	0.65	0.70	0.65	0.60	0.55	0.50	0.25	0.13	0.00	0.00

An assumption of the model is that there will always be sufficient adult males with which to breed – an assumption which may not be satisfied if, for example, sport hunting quotas are too high. Taylor (1985) found no males older than 10 years in breeding herds so it can be assumed that once sport hunting starts to affect the male age classes below 10 years old female conception may be reduced.

(3) Fecundity Taylor (1985) found the average fecundity for adult female buffalo in Matusadona was 0.7 calves (of both sexes) per adult female per year. This indicates a calving interval of 17.2 months, i.e. post-partum anoestrus lasts for about 6 months. This rate of calving is very high and implies two calves every three years (which is in fact what the Matusadona population achieved). The only higher rate of calving in the literature is that of 0.8 calves per year (i.e. 4 calves every 5 years) recorded by Sinclair (1977) for the Serengeti in East Africa.

Taylor (1985, p377) gives the results of several studies of buffalo from different parts of Africa under rainfall conditions varying from 400-1200 mm per year and concludes that there is a strong relationship between rainfall and fecundity in arid and semi-arid areas (**Fig.3**). The code letters above the data points refer to B-Botswana, K-Kruger National Park, R-Rwenzori NP Uganda, S-Serengeti and A-Aswa Lolim, Uganda. The last data point is in a high rainfall area where factors other than rainfall limit fecundity (e.g. the physiognomic vegetation type). In the model which follows, this relationship has been used to estimate average fecundities for buffalo over the range of rainfall in Namibia where buffalo might occur. The results are shown on the next page.

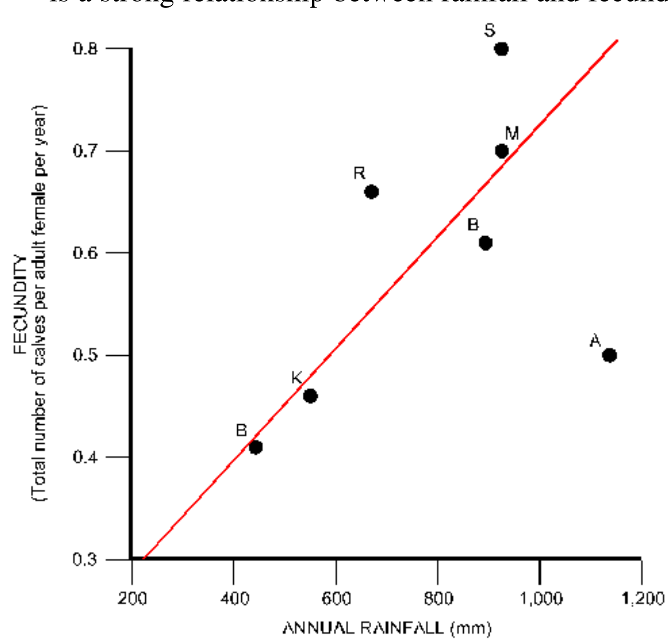


Figure 3: Average Fecundity for all female buffalo over a range of rainfall

Annual Rainfall (mm)	200	300	400	500	600	700
Average Fecundity	0.288	0.343	0.397	0.452	0.507	0.563

(4) Mortality Most studies on buffalo have found that juvenile mortality is the key parameter determining the growth rate of the population. A confounding factor in all the studies examined in preparing this report is the extent to which observed juvenile mortalities are dependent on population density as opposed to being an independent parameter. Taylor (1985) found about 16% mortality in the first year of life for buffalo in Matusadona which is low compared to that found in Kruger National Park by Pienaar (1969) who stated that ".... only 6-9 out of 20 new-born calves reach reproductive maturity". Taylor's mortality levels for 2-4 year old animals were extremely low and, if applied to Pienaar's data, would suggest that most of the indicated mortality of 55-70% occurred in the first year of life. It is tempting to conclude that the population studied by Pienaar was already showing signs of density dependent regulation whereas the population studied by Taylor was a long way below any asymptote for carrying capacity. This conclusion is strengthened by Pienaar's observation that heavy mortalities occurred in large herds (500+ animals) whereas juvenile survival in small herds (<100 animals) was far higher. It is not difficult to see why juvenile mortality would be higher in large buffalo herds: increased intraspecific competition for food and water, stresses imposed on young animals by large herds having to travel large distances in search of adequate grazing; increased opportunities for predators – all would act in concert to increase juvenile mortalities.

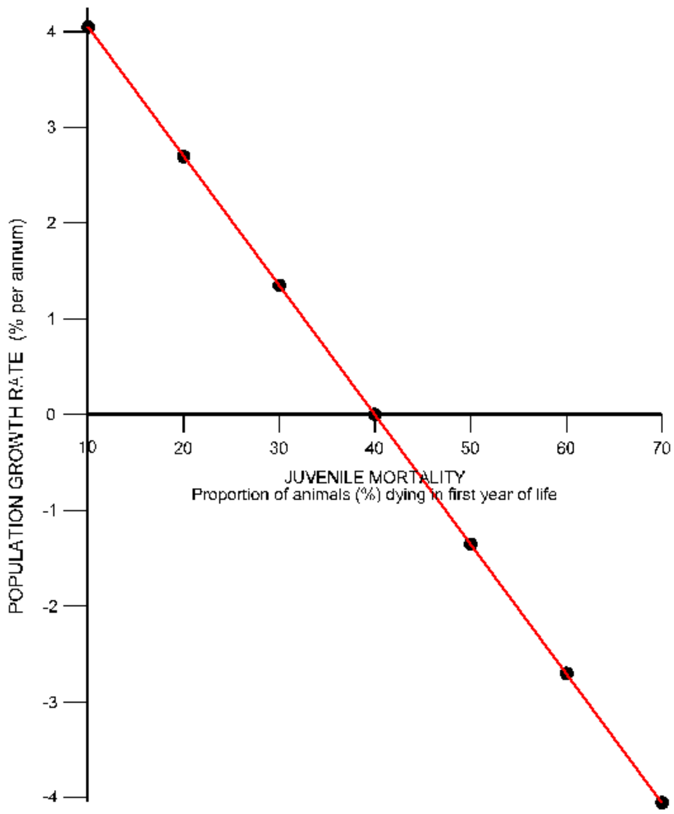
The age specific mortality schedule for the population model in this study is based on Taylor (1985, p441) for all age classes above one year. Because the sex ratios in buffalo populations are very close to unity the same mortality schedules can be used for both males and females. Mortality for two-year old animals has been set at 5%, a constant mortality of 3% is maintained from 3 - 11 years old and the mortality from 12-18 years is such that in a population of 1,000 animals one animal survives to an age of 18.

AGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Mortality %	??	5	3	3	3	3	3	3	3	3	3	5	10	15	20	40	60	80
Survival	??	0.95	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.95	0.90	0.85	0.80	0.60	0.40	0.20

I have examined the effect of different juvenile mortalities on the population over a range from 10% to 70% mortality in the first year of life, using the fecundities given in the table on the previous page (which are centred on a nominal fecundity of 0.5 calves per adult female per year). If the mortality in the first year of life is higher than 50% the population does not increase and for values of 60-70% the population declines. The results are shown in **Fig.4** on the following page.

Figure 4: Relationship between juvenile mortality and population growth rate

Juvenile Mortality %	10	20	30	40	50	60	70
Rate of population growth %	6.60	5.27	3.77	2.15	0.30	-1.54	-3.09



On the basis of these data, I have selected a juvenile mortality of 20% for the first year of life which is slightly higher than that found by Taylor (1985) but considerably lower than Pienaar's (1969) estimates. Indeed, Pienaar's juvenile mortality figures would result in population extinction very quickly. A juvenile mortality of 20% effectively assumes that the buffalo populations to which the model is to be applied are at present well below carrying capacity and not subject to any internal pressures of density dependence.

(5) Density dependence Sinclair (1977) shows that buffalo populations are regulated by their food supply – which is ultimately regulated by rainfall and soil fertility. The regulation acts mainly to increase buffalo mortality: fertility does not appear to be greatly affected although it can be expected that the age at first conception would tend to occur slightly later as it is dependent on the physical condition of females. For the purposes of the population modelling which follows, density dependence has been ignored (it has been taken into account in the next main section which examines carrying capacity for different areas).

We are now ready to present a simple population model which enables analysis of population growth rates and age structures (**Table 2**).

Table 2. A POPULATION MODEL FOR BUFFALO

START	0	**Nominal starting population:**	**1,000**
YEAR	1	**Average fecundity:**	**0.5**

AGE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	**TOTALS**
Starting Cohort																			
Males	52	41	38	37	36	35	34	33	32	31	30	29	28	26	20	10	5	1	518
Females	52	41	38	37	36	35	34	33	32	31	30	29	28	26	20	10	5	1	518
Running Cohort (population from previous year)																			
Males	52	41	38	37	36	35	34	33	32	31	30	29	28	26	20	10	5	1	518
Females	52	41	38	37	36	35	34	33	32	31	30	29	28	26	20	10	5	1	518
Fecundity	0.00	0.00	0.00	0.05	0.16	0.40	0.55	0.60	0.65	0.70	0.65	0.60	0.55	0.50	0.25	0.13	0.00	0.00	
Calves	0	0	0	1.9	5.8	14	19	20	21	22	20	17	15	13	5	1.3	0	0	174
Population after births																			
Males	87	52	41	38	37	36	35	34	33	32	31	30	29	28	26	20	10	5	604
Females	87	52	41	38	37	36	35	34	33	32	31	30	29	28	26	20	10	5	604
Population after annual mortality																			
Survival	0.80	0.95	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.95	0.90	0.85	0.80	0.60	0.40	0.20	
Males	70	50	40	37	36	35	34	33	32	31	30	29	26	24	21	12	4	1	545
Females	70	50	40	37	36	35	34	33	32	31	30	29	26	24	21	12	4	1	545
																		TOTAL POPULATION	**1090**
																		RATE OF GROWTH %	**5.21**

The model behaves in a manner similar to the Leslie matrix (Leslie 1984) but the calculations of births and deaths are separated into successive operations because it is designed to cycle within the row operations of a computer spreadsheet. The model operates as follows –

(1) The starting year is set to zero, and a nominal starting population and average female fecundity are set in the indicated cells.

(2) In the two rows immediately following, the starting population is divided into equal numbers of males and females and further divided into numbers in each age class

which approximate a stable age distribution.

(3) In the first year of the model, this cohort of males and females is transferred to the next two rows of the model ("Running cohort"). On each successive cycle of the model thereafter, the running cohort derives its population values (males and females) from the last two lines of the model.

(4) On each cycle of the model the individual number of females in each class is multiplied by the fecundity in the cell immediately below it to give the number of calves produced by each female age class.

(5) The number of calves is summed at the end of the row, divided by two and inserted in the first two cells of the next two rows ("Population after births"). At the same time the number of males and females in each cell of the running cohort above is moved forward by one year and inserted in the cells following the one year old age class, i.e. ta the same time as the births occur each animal in the population ages by one year.

(6) The individual male and female cells of the "population after births" are then multiplied by the survival values in the next row to give the "Population after annual mortality".

(7) The population is then totalised and the growth rate is calculated using the increase in the population over the number at the start of that particular cycle (which is the total number of animals in the "Running cohort").

(8) The cycle is then repeated as many times as desired (usually until the age structure becomes stable and the growth rate does not change from year to year).

The first use of the model is to examine various rates of population growth expected under different fecundity regimes, with the average fecundity being set by rainfall (see subsection (3) on page 7).

Annual Rainfall (mm)	200	300	400	500	600	700
Average Fecundity (calves/year)	0.288	0.343	0.397	0.452	0.507	0.563
Expected Population Growth Rate %/year	-0.48	1.18	2.71	4.13	5.41	6.61
Population doubling time (years)	–	59.2	25.9	17.2	13.2	10.9

Under Namibian rainfall conditions it can be expected that in the wetter east of the Caprivi (rainfall 600-750mm) buffalo populations will be able to increase rapidly with doubling times of 10-13 years. In the west of the Caprivi (rainfall 500-600mm), populations could double in 13-17 years. In those areas in the main body of the country where annual rainfall is of the order of 300-400 mm growth rates are likely to be low (<3% per annum). Where rainfall is less than 250mm buffalo are unlikely to survive.

e. Distribution

The distribution of buffalo in Namibia and its neighbouring countries can be conveniently considered in three major 'epochs' –

(1) The time before the great rinderpest epizootic (1890-1900);

(2) The period after the rinderpest and up to the erection of the major veterinary control fences in Botswana, Namibia and Zimbabwe (1958-1996); and

(3) The present situation.

(6) The Pre-Rinderpest Period

Buffalo were widely spread throughout the southern Africa savannas and occurred in most vegetation types including lowland and montane forest, moist and dry woodlands, and open savannas and grasslands except where rainfall was limiting and other requirements such as shade and water could not be met.

Sinclair (1974c) tabulated crude buffalo densities in a number of protected areas in eastern and southern Africa and found a strong correlation between density and rainfall. From these data he developed a regression line (-8.54 + 0.017 x Rainfall) which enabled reasonable predictions of ceiling buffalo densities over a range of rainfall from 500 - 2,000 mm of rainfall. Sinclair's regression predicted that buffalo would not survive below 500mm of rainfall but he recognised that the existence of large perennial rivers in otherwise arid areas enabled buffalo to survive down to an annual rainfall of about 250mm.

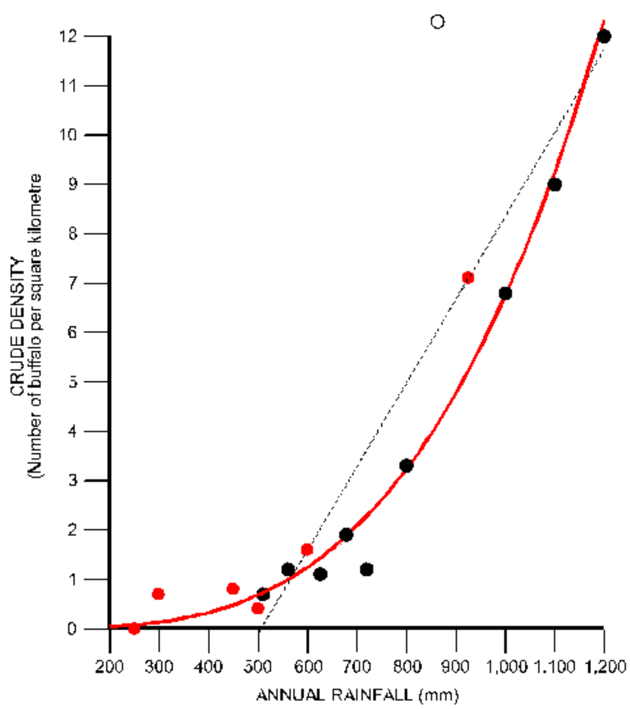


Figure 5: Relationship between buffalo density and rainfall

Sinclair's dataset does not include any occurrences of buffalo below 500mm of rainfall and so I have added a number of additional data points for the low rainfall areas in southern Africa where reasonable survey estimates exist (Northern Botswana, Hwange/Matetsi, Gonarezhou and the Zambezi Valley). I have also added Taylor's (1985) estimates for Matusadona National Park and Stewart and Stewart's (1963) postulation that buffalo do not survive in areas with a rainfall lower than 250mm. This additional data suggests a relationship which is not linear (**Fig.5**) and I have fitted a curve which allows fairly accurate predictions of existing densities down to 250mm of rainfall.

(Density = 8.5 x 10^{-10}(Rainfall)$^{3.3}$)

Sinclair's regression line is shown together with his original data points (•) up to 1200mm of rainfall. I excluded one unusually high density point from the relationship (Albert Park, Zaire - ❍). The additional data points (•) and the new fitted curve are shown in red.

I have used this relationship to predict theoretical carrying capacity densities for buffalo in southern Africa based on the rainfall map of Cumming (1999, Map 2.4). The rainfall map (**Fig.6**) and the predicted buffalo densities (**Fig.7**) are shown on the following two pages. The results are interesting and plausible.

Buffalo would have occurred throughout Zimbabwe and Zambia and almost all of Botswana and Angola except for their extreme south-western corners. Smithers (1983) remarks on the wide coastal distribution which once existed in the Cape province of South Africa – of which only the relict Addo population now survives. The occurrence of buffalo in the Cape peninsular is confirmed from early historical records (Skead 1982). Skead also gives records of buffalo near Kakamas in the northern Cape in 1777, near Augrabies Falls in 1779 and 65km west of Springbok (all of which are slightly west of the red line shown on Fig.7).

In Namibia, the range for buffalo may once have been larger than shown (**Fig.8**). Skead (1982) thought that buffalo would have frequented the full length of the Orange River and gives records on the Löwen River near Keetmanshoop in 1761; on the Lewer River near Gibeon in 1791; again on the Löwen River in 1835; and at Bullspoort near the Naukluft Park in 1837. Brown (2000) notes the occurrence of buffalo, albeit perhaps as a seasonal visitor, to the Gondwana Canyon Park east of the Fish River Canyon.

(7) <u>The Twentieth Century</u>

The great rinderpest epidemic reduced buffalo to very low numbers throughout southern Africa and the Namibian population, which over most of its range lived in marginal conditions anyway, was brought to extinction except in the Caprivi. Records in the early 1900s give frequent sightings of buffalo in the Caprivi – where, because of its more favourable rainfall and its location, populations were able to recover quickly.

In the main body of Namibia populations recovered more slowly, with the recolonisation coming from Botswana and Angola. There are early sightings in the Khaudom area (Mattenklodt 1916, [in Gaertes 1967]) and in Ovamboland (Hahn 1925). Buffalo increased their range southwards and westwards and, by the 1950s, records were common in the Grootfontein, Otjiwarongo and Gobabis farming areas (Gaertes 1967). A sighting is reported in the Windhoek farming area in 1957 and a small group of buffalo had established themselves in Etosha by 1963. However, the expansion of buffalo was to proceed no further: from the 1960s onwards, the epoch of veterinary control fencing was to determine the future distribution of buffalo in southern Africa.

The reduced buffalo range within Namibia is shown in **Fig.9** together with recorded buffalo presences south of the veterinary fence. None of these buffalo survive today.

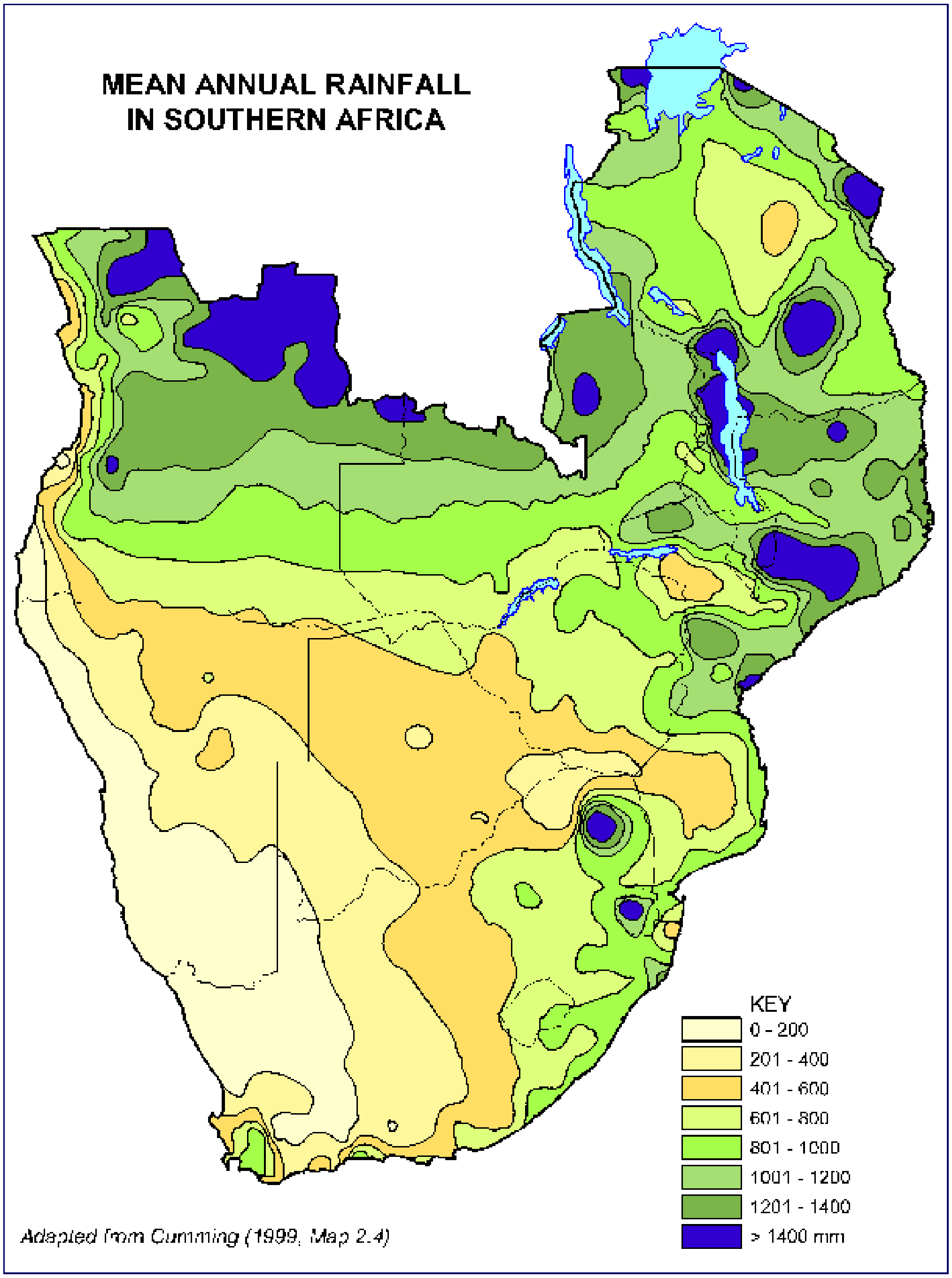


Figure 5: Mean annual rainfall in southern africa

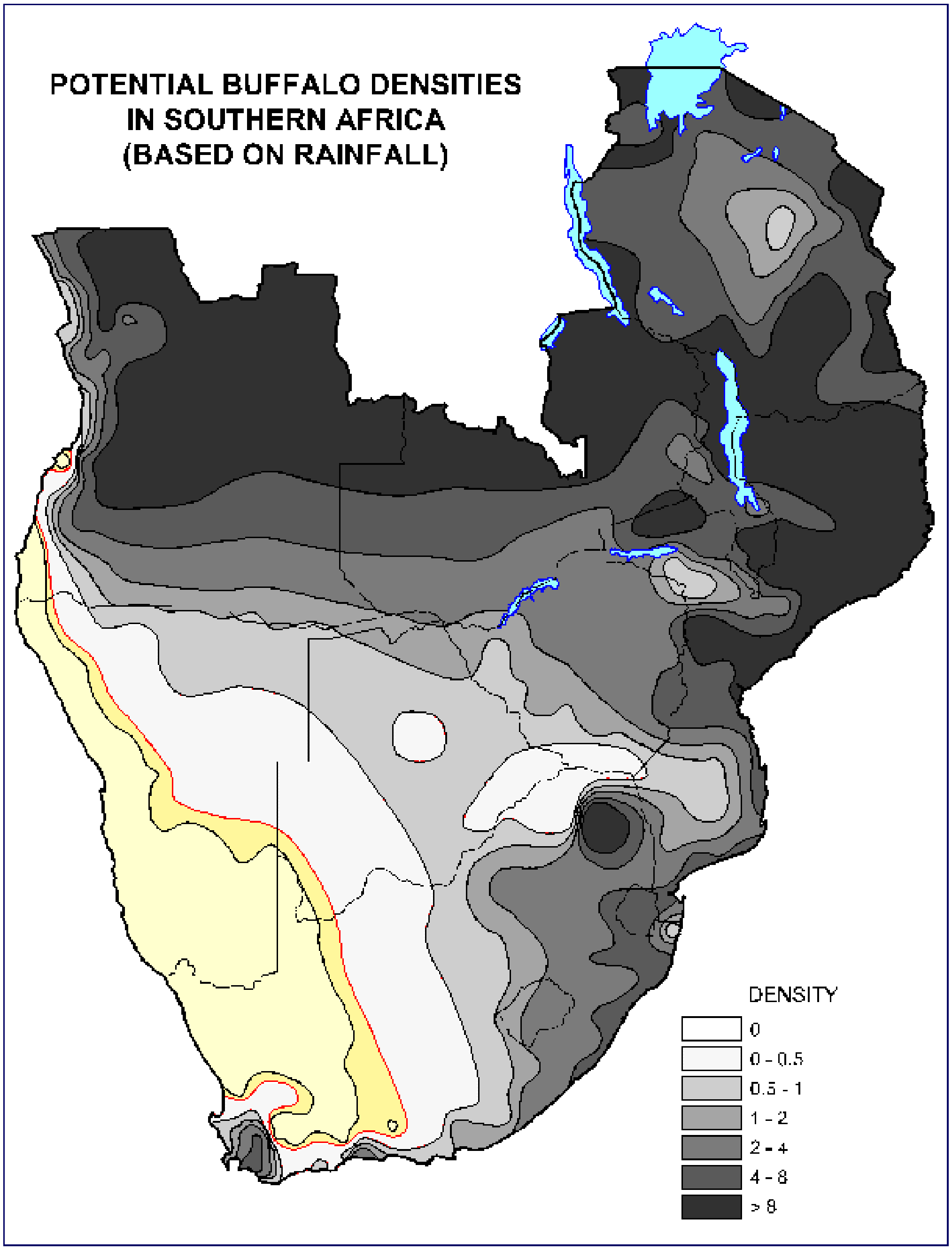


Figure 7: Potential range and crude carrying capacities for buffalo in Southern Africa

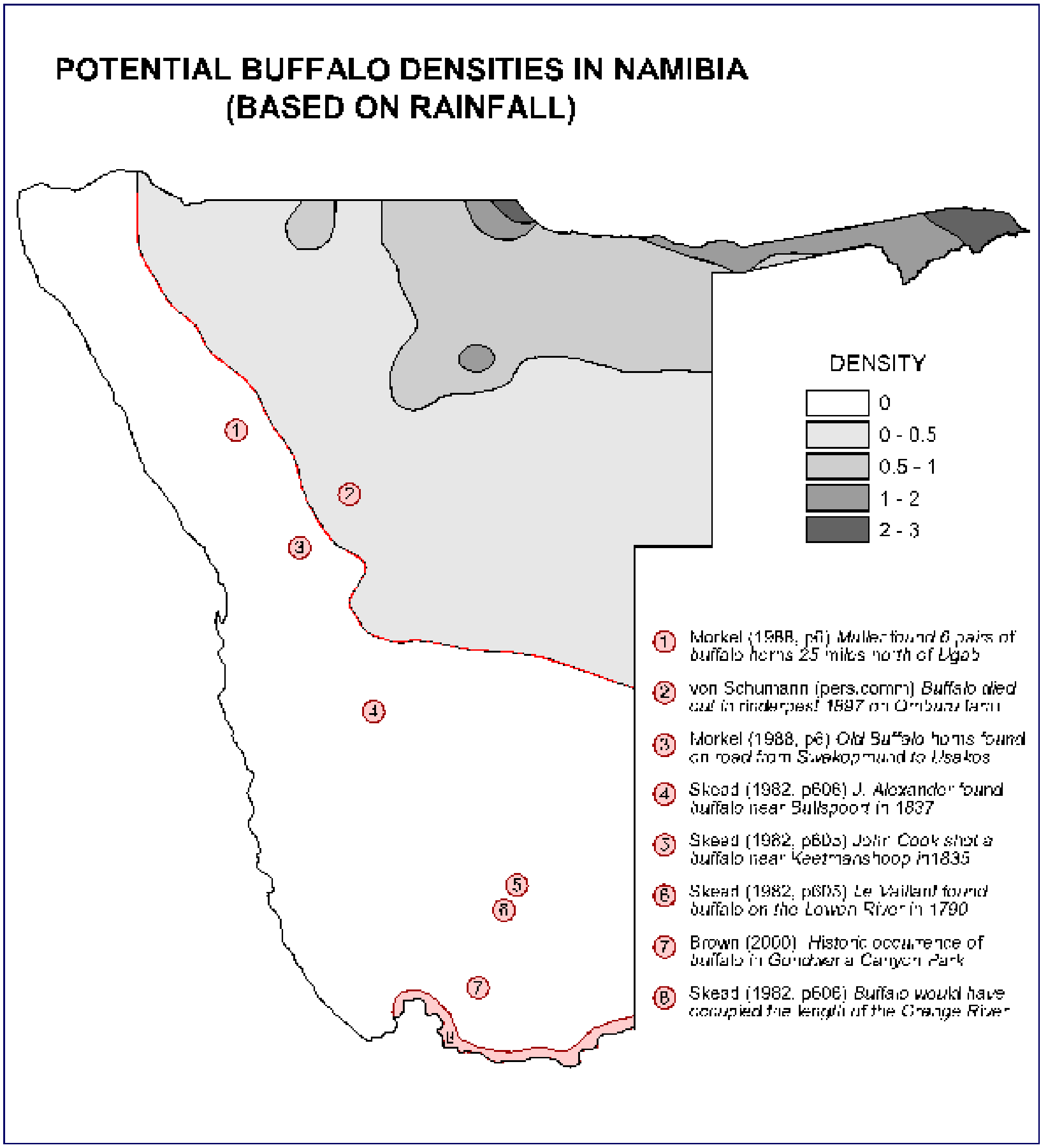


Figure 8: Historic distribution of buffalo in Namibia based on rainfall isohyets

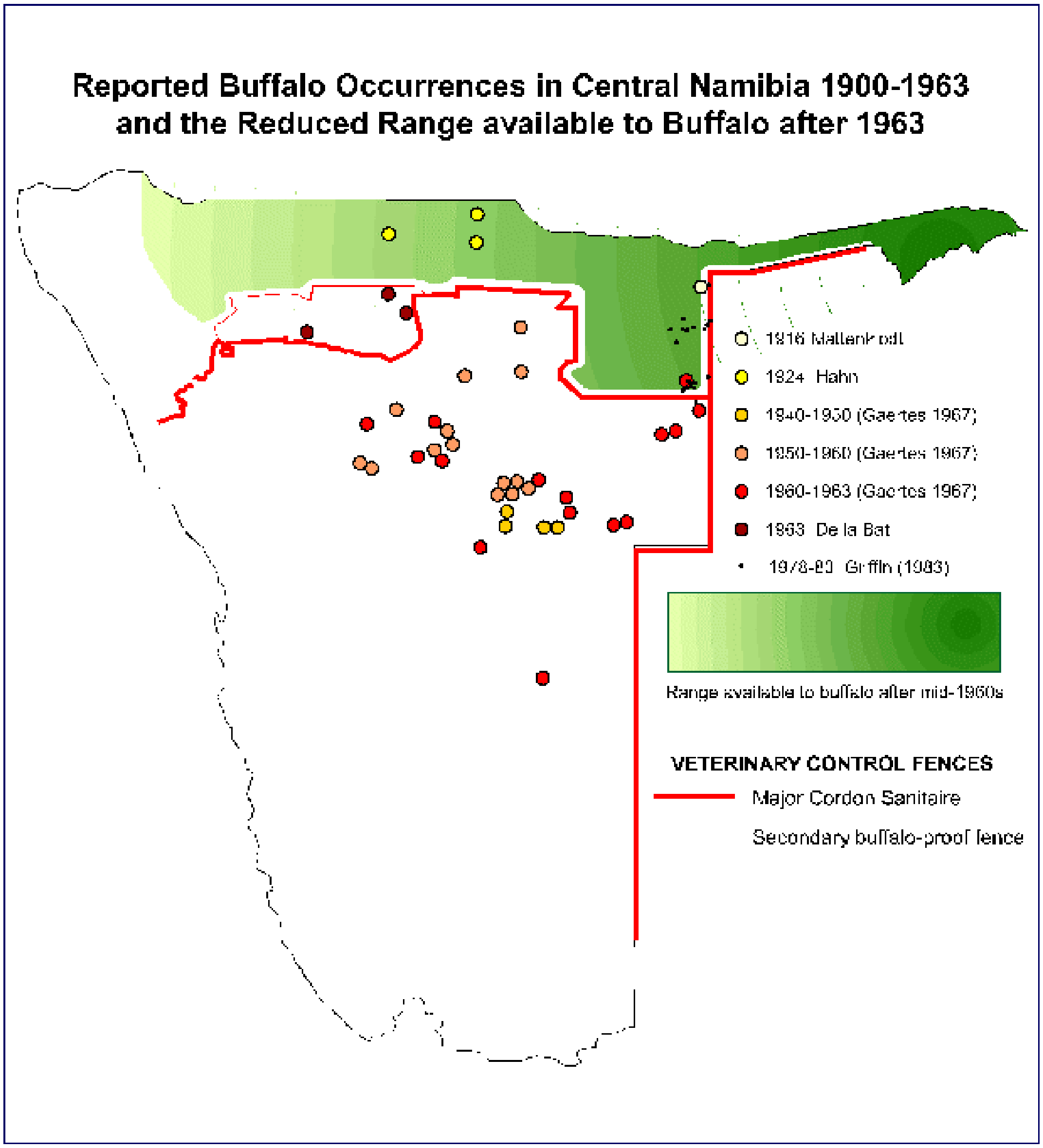


Figure 9: The present range available to buffalo in Namibia

The veterinary fence along the international boundary between Botswana and Namibia came into place in the early 1960s. In Botswana, the first cordon fence – the Kuke fence – was constructed in 1958. The period from 1960 to the present time is characterised by continuous modification and addition of veterinary control fences in Botswana, Namibia, South Africa and Zimbabwe. The main veterinary fences affecting buffalo at the moment, together with their dates of construction, are shown in **Fig.10** on page 20.

Buffalo were eradicated from large areas as part of the veterinary campaign but, in any case, the construction of the fences alone would have been responsible for many deaths. Volker Grellmann[2] (pers. comm.) related the fate of some 200 buffalo in the Bushmanland area which were isolated from Botswana by the international boundary veterinary fence. Most of this group died of thirst and starvation and, by 1988, the only survivors were 18 of the original herd which later formed the nucleus for the present foot and mouth disease-free herd in Tsumkwe. It is significant that, up until the time of their quarantine in 1996, this herd had been in regular contact with cattle without transmitting the disease.

The reduced range available to buffalo in the transboundary project area is shown in **Fig.11** on page 21. Of particular significance is the convoluted shape of this range in northern Botswana. In theory, through a disjointed set of breaks in the Botswana veterinary fences, the present buffalo range could extend as far south as the Makgadikgadi Pans: in practice, the obstacles to their movement are likely to preclude this.[3]

The preoccupation of State veterinarians in the 1960s was to protect cattle against Foot and Mouth disease infections from buffalo.[4] However, in the past 40 years the number of diseases which potentially affect cattle and which now have to be considered as veterinary control problems has increased exponentially and produced a complex situation. Morkel (1988) gives an excellent catalogue of these diseases which I have summarised in the **Table 3** on the following page. It is clear that there a number of strong arguments for keeping wild buffalo[5] separated from cattle – as much for their own protection as for the possible threat to cattle.

Wildlife management where buffalo is a component is a land use which competes with cattle ranching. Such competition should be seen as economically healthy and, in a time of changing market values, it is in the national interest that neither of the two alternative land uses should prejudice the other. Rather, the most efficient of the two land uses should ultimately predominate or a balance should be reached where each land use is occupying the economic and ecological niche where it is more profitable than the other. What should not be acceptable are measures which foreclose options or artificially subsidise one or other of the two land uses. The land use

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2. Chair, Namibian Professional Hunters Association (NAPHA)
3. In fact, the last surviving buffalo in the Makgadikgadi Pans area were translocated to the northern part of the buffalo range in the year 2000 (Larry Patterson, pers.comm.)
4. In Zimbabwe, the first control fences were actually established as frontiers against tsetse fly dispersal.
5. The term ‘wild’ buffalo is used here to make the distinction between foot and mouth disease-free buffalo and large naturally occurring populations.

value of buffalo is pursued further in Section 2.

Table 3: Diseases affecting cattle and buffalo

DISEASE	CHARACTERISTICS
Foot and Mouth (FMD)	Virus transmitted from buffalo to cattle with difficulty but also now established in some cattle herds. At least 7 varieties of the virus are documented – increasing problems of vaccination. Buffalo only wildlife host to the disease. Control critical for beef export industry.
Corridor Disease = Theileriosis ≈ East Coast Fever	Protozoan parasite transmitted to cattle by ticks which feed on buffalo. Cattle unable to pass the disease on to other cattle. Buffalo only wildlife host to the disease. Waterberg buffalo in Namibia are free of the disease.
Bovine Tuberculosis	Bacterial disease affecting man and animals. Initially transmitted from cattle to buffalo and has deleterious effects on buffalo. Can be re-transmitted back to cattle by buffalo.
Contagious Bovine Pleuropneumonia CBPP	Bacterial disease of cattle and other ruminants usually causing death. Occurs in northern Namibia. Disease not recorded in wild buffalo but infection possible with negative effects for buffalo. Hence cattle should not come in contact with buffalo.
Rinderpest	Acute virus disease of cattle which devastated buffalo in 1900s. Not present in southern Africa but nearby in East Africa posing a real threat to buffalo and cattle.
Others	Anthrax, brucellosis, trypanosomiasis, coccidioisis, leptospirosis, fascioliasis. Affect both cattle and buffalo and are an argument for keeping them separated.

(8) The Present Distribution

The present distribution of buffalo in the project area is shown in **Fig.12** on page 22. This map has been constructed from Cumming (1999, Fig.2.17), updated with information from ASG (1998a, p106) and further modified with new data from Namibia and Zimbabwe. The data from Angola and Zambia are not recent. IUCN ROSA (1992, p67) describe the situation in Angola as follows –

> *"Seventeen years of civil war, with troop movements through national parks, uncontrolled hunting and the paralysis of government park administration have left the system of national parks and reserves in a shambles."*

Enquiries about the current distribution of buffalo have been initiated in the course of this study with the Angolan authorities but as yet no information has been forthcoming. Similarly, enquiries have been initiated in Zambia without response. The range for buffalo in Zambia as depicted in Fig.12 is likely to be an overestimate as it is known that there is dense human settlement in the extreme south-western corner of Zambia along the Zambezi River adjacent to the Caprivi Strip. This settlement effectively creates a disruption in the buffalo range in the vicinity of the nearest State protected wildlife area (Sioma-Ngwezi National Park) since the actual protected area frontage shared by Namibia and Zambia here is only about 15km.

The final figure in this series, **Fig.13** on page 23, overlays the range which buffalo currently occupy (Fig.12) on the range which is presently available (as determined by veterinary fences, Fig.11) and the range which was available to buffalo in the distant past (determined by suitable habitat, Fig.7). The impression is one of a much circumscribed population.

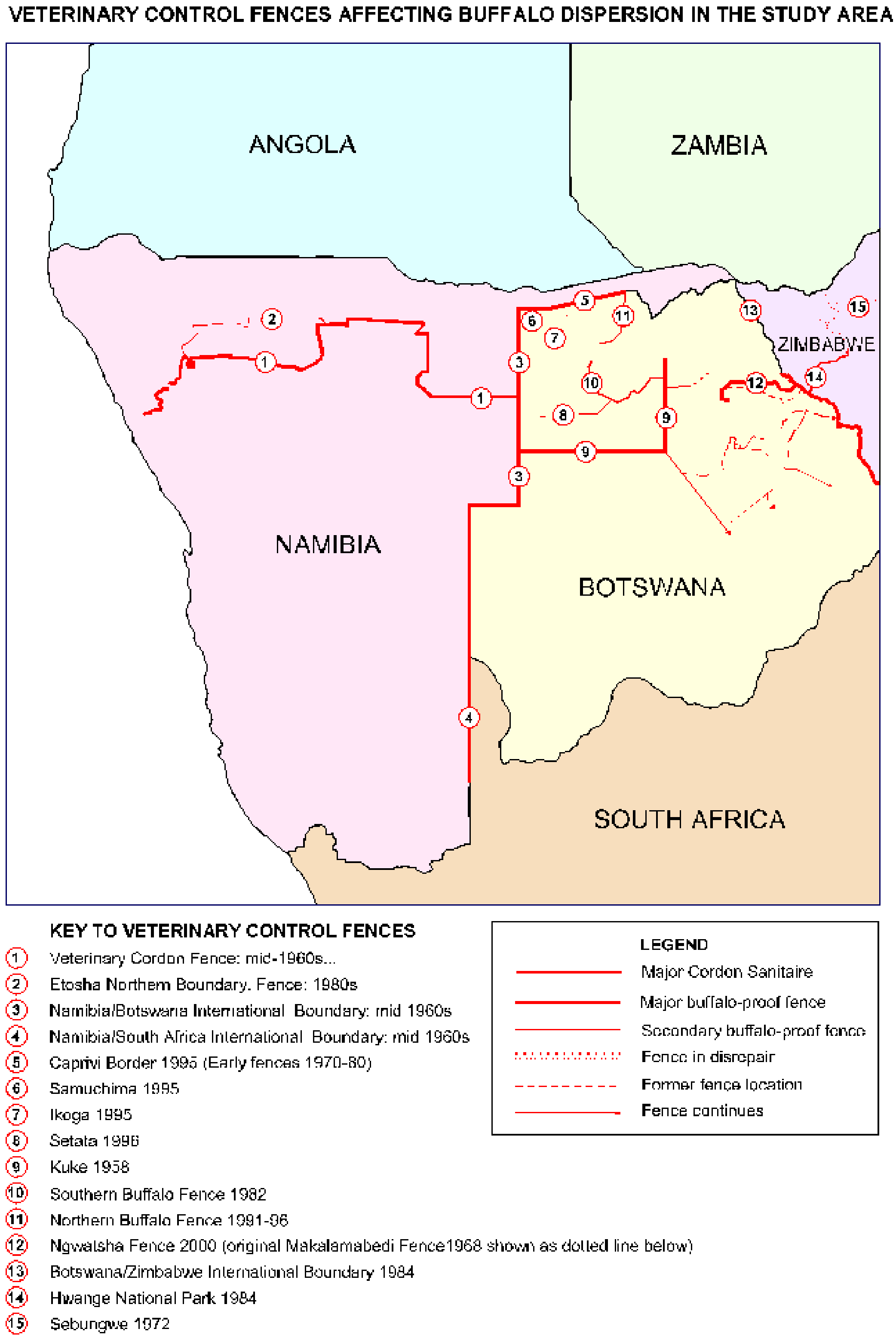

Figure 10: The location of veterinary control fences

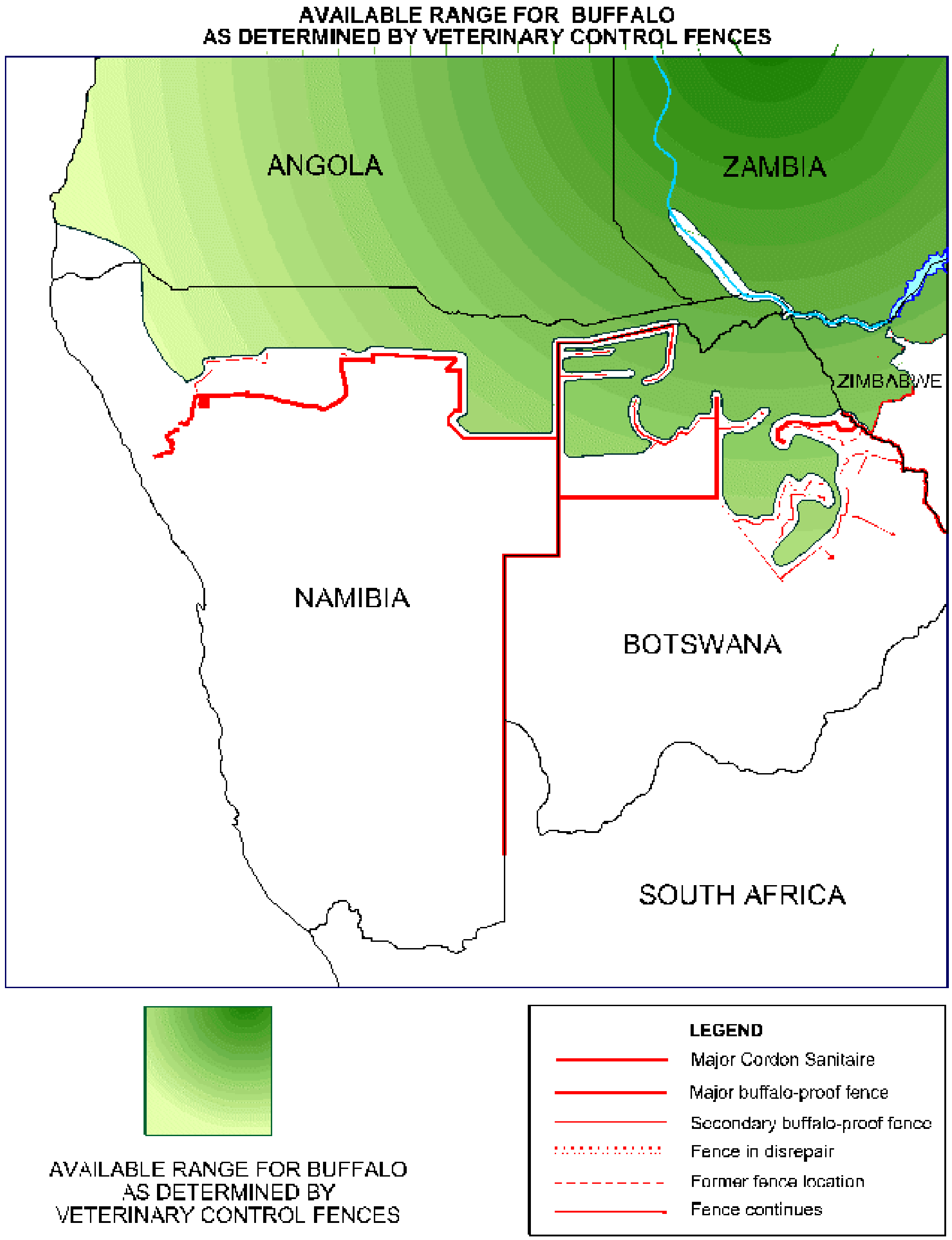

Figure 11: The range available to buffalo in the Project Area in 2002

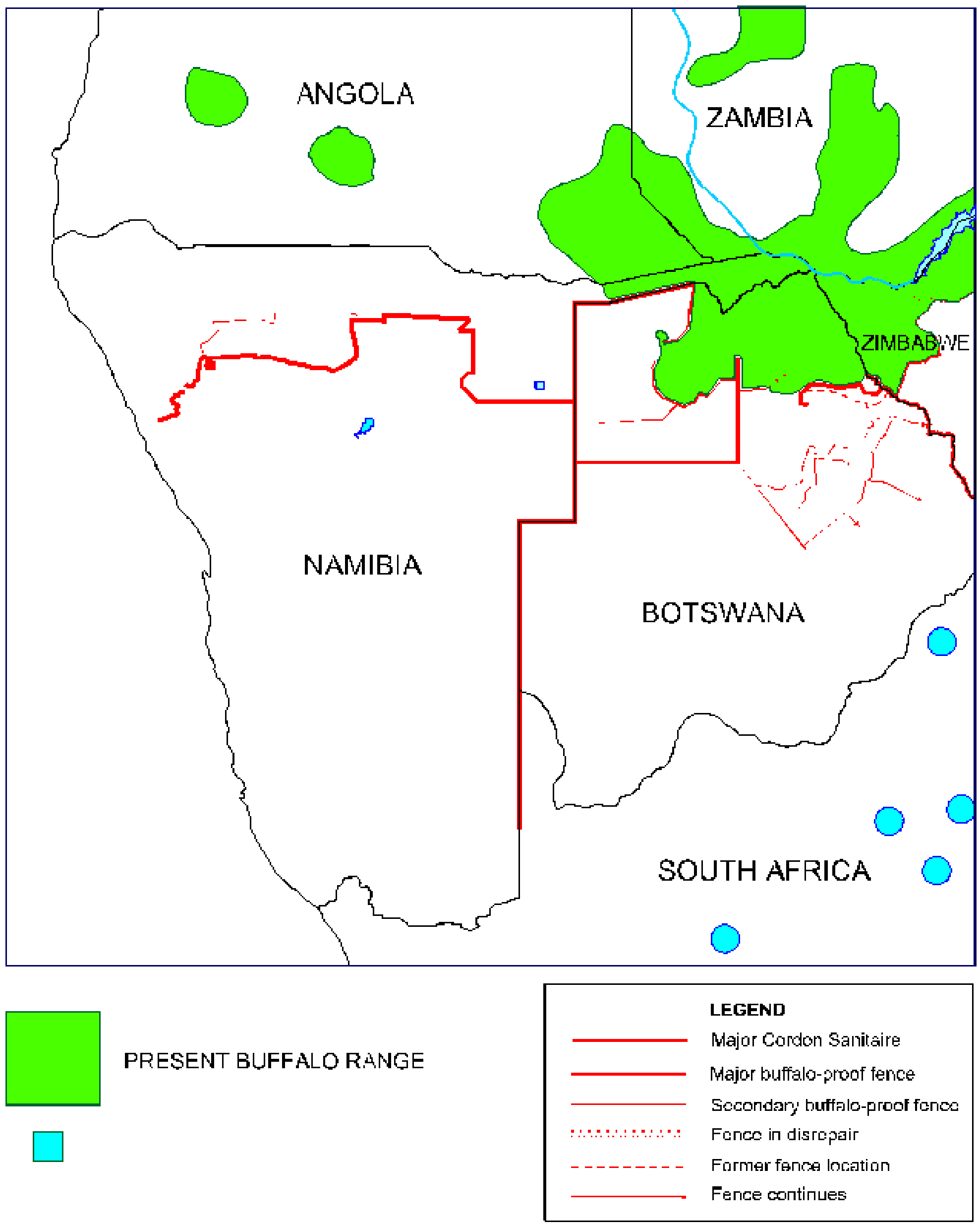

Figure 12: Present distribution of buffalo in the Project Area

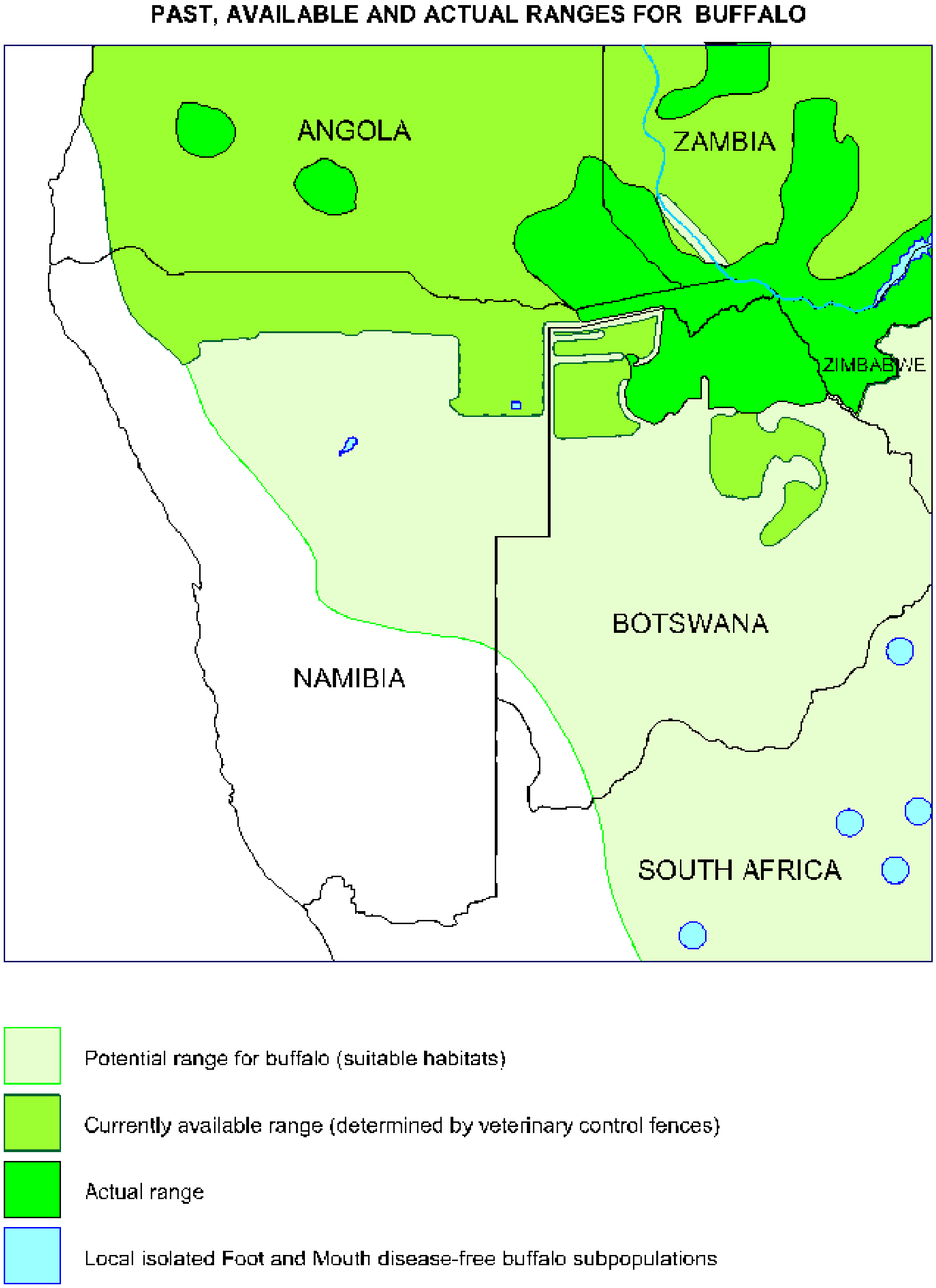

Figure 13Past, recent and present distribution of buffalo in the Project Area

Before concluding this section, I examine at a much smaller scale the actual and potential distribution within the Caprivi – where the main population of buffalo in Namibia is found (**Fig. 14** on the next page).

Using the data from the Caprivi Atlas (Mendelsohn and Roberts 1997), I have attempted firstly to produce a maximum possible range for buffalo by excluding all consolidated areas of land cleared for agriculture and areas where human populations exceed 20 persons/km^2. This removes about 2,500 km^2 of land, mainly in the far east and far west of the Strip, from the total area of 20,000 km^2 to give an area of about 17,500 km^2. In doing this, it is assumed that water supplies for buffalo could be developed in the central part of the West Caprivi.

I have then produced a more modest range which excludes virtually all cleared areas no matter how small, excludes areas where the human densities are greater than 10 km^2 and excludes areas to which buffalo are unlikely to gain access because of the bottlenecks created by surrounding agriculture. This area amounts to slightly more than 9,000 km^2.

Finally, I present a “core range” of about 5,000 km^2 based on occurrences of buffalo recorded in the various aerial surveys since 1987. This resembles the range given by Mendelsohn and Roberts (1997, p31) but includes most of the Forest Reserve as potential core area and excludes the southern part of Kabe and Katimo Mulilo constituencies where dense agriculture is likely to preclude the long term survival of buffalo.

Rounding the results, the ranges can be summarised as follows –

BUFFALO RANGE	Area km^2	Cumulative
1. Core area where buffalo should reach full carrying capacity	5,000	5,000
2. Additional range which buffalo might reasonably be expected to colonise if water supplies are developed, conservancies fulfil expectations and illegal hunting is minimised	4,000	9,000
3. Further range which buffalo might occupy under favourable policies with active promotion and major incentives for local communities	8,000	17,000

There are certain key observations pertaining to the buffalo range shown in Fig.14. The human propensity to colonise river frontages could not produce a worse situation for buffalo. In the extreme western Caprivi a large part of the potential range is denied to buffalo by the settlement on both banks of the Kavango River north of the main road; in the area east of the Kwando River ‘ribbon’ subsistence cropping restricts buffalo access to water and creates a barrier to the Forest Reserve to the east; and the potential buffalo range along the Chobe River is severely threatened by an almost continuous belt of settlement. There are two other areas of serious concern. Settlement between Mudumu National Park and the conservancies to the north and along the southern boundary of the Forest Reserve is creating a barrier which will separate ‘southern’ buffalo from ‘northern’ buffalo. Settlement along the northern boundary of Mamili National Park will soon isolate this buffalo population completely.

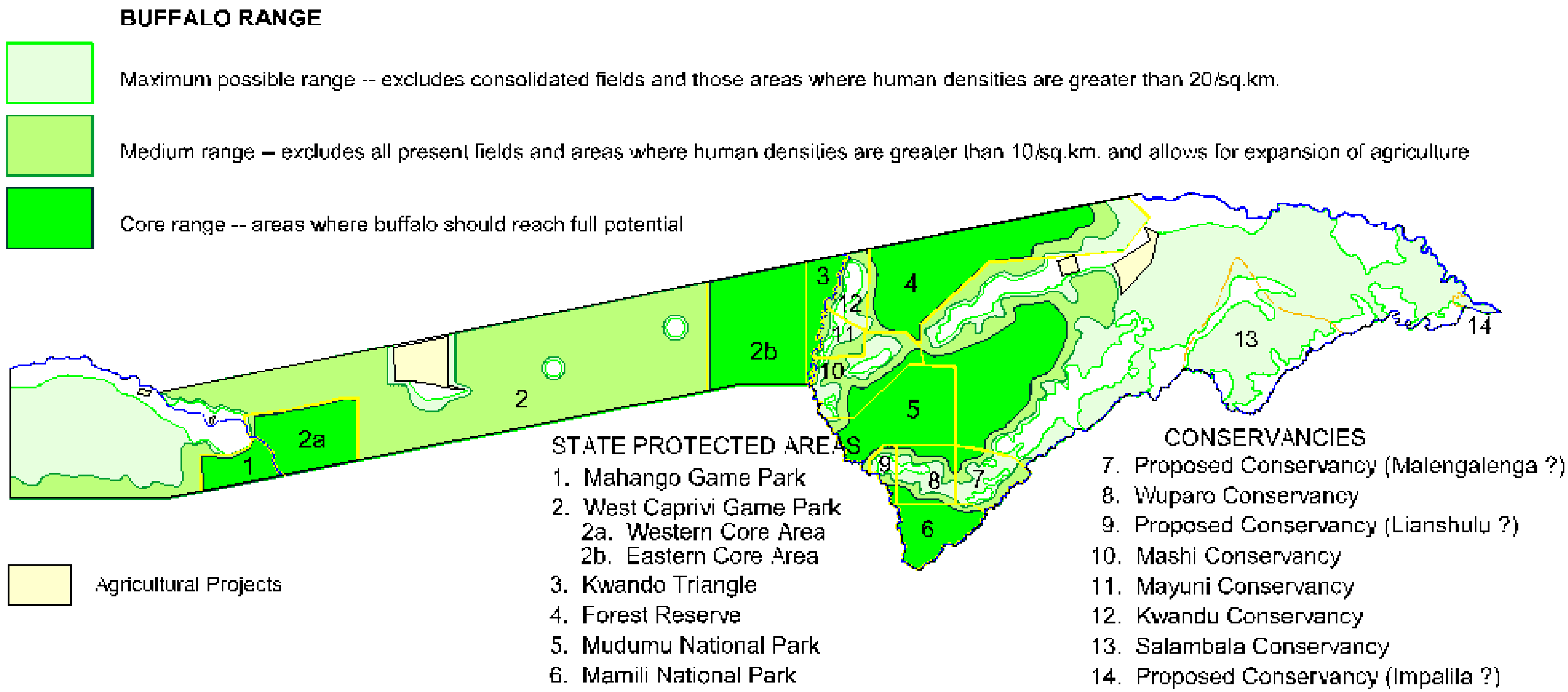

Figure 14: Present and potential buffalo range within the Caprivi

f. Numbers

At the outset of this section, it is necessary to point out the major difficulty which arises when standard sample survey techniques are used for buffalo. The typical semi-random distribution of most large mammal species can be well captured by transects flown about 1km apart with a strip width of about 150m each side of the aircraft. The estimate which results from sightings which fall within the stripwidth is usually fairly precise with statistical confidence limits which can be better than ± 20% of the value of the estimate.

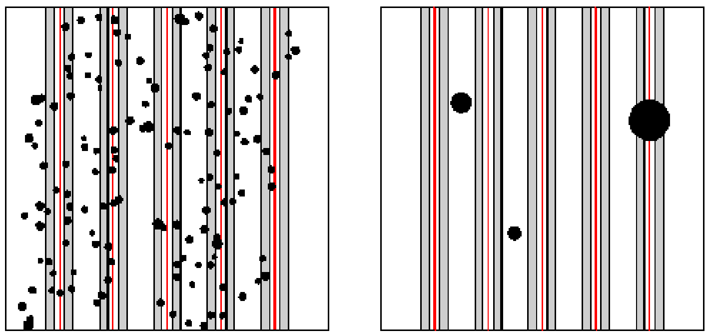

Figure 15: The difficulty with buffalo surveys

Because buffalo occur in large herds which may exceed 500 animals and may cover a physical area which spans more than one adjacent transect line, the errors which may arise from estimating numbers are potentially large. For example, if the entire buffalo population in a particular survey stratum exists as one large herd of several hundred animals and that herd happens to fall outside the survey strip width, the estimate for the population is zero. If the herd fall entirely within the strip width, the estimate is high when the sample area is extrapolated to the total stratum area and there are no confidence intervals because of the single data point. A range of intermediate situations can arise, all of which give rise to the very large confidence intervals which are associated with buffalo estimates.

A second problem is the inability of observers to make accurate estimates of numbers when confronted with very large groups – the general tendency is to underestimate (Sinclair 1973). The problem is exacerbated when a herd is partly in and partly out of the transect strip width and when the observer is called upon to make an estimate when moving at a forward speed of 100km/hour.

At present there is no acceptable alternative to the standard transect survey method or the random block count method. Systems which rely on "total counts" or "actual observations" are statistically inferior because no accuracy or precision can be attached to the estimate. In the final part of this report under 'best practices' for management, the subject will be pursued further. In examining the estimates which follow, confidence intervals for individual surveys will not be given and it should be tacitly understood that they are high.(typically ± 40-90% of the estimate). Thus caution needs to be exercised in pronouncing apparent upward or downward trends in populations.

This section is limited to an examination of numbers of buffalo in Botswana, Namibia and Zimbabwe – as explained in the last subsection, no data is to hand for Zambia and Angola.[6]

The wildlife authorities in Botswana have systematically carried out annual surveys in both dry and wet seasons for most years since 1987. The estimates for the buffalo population are shown in **Table 4** opposite and plotted in **Fig.15** on page 30. The estimates which have been used are those for the 'potential population' (DWNP 2000b) – obtained by extrapolating the estimate for the area surveyed in the given year up to the total area of 145,605km^2 which is the wildlife range in northern Botswana. In most of the years concerned the actual area surveyed is more than 95% of the total area so that this correction is unlikely to inflate the results.

Table 4: **Estimates of the Botswana buffalo population**

YEAR	Wet Season	Dry Season
1989	—	59,694
1990	30,557	94,527
1991	47,743	61,700
1992	37,075	44,500
1993	66,570	—
1994	24,797	29,960
1995	19,107	20,945
1996	—	35,043
1997	—	—
1998	—	—
1999	19,137	93,002
2000	—	—
2001	—	82,674

The wet season estimates are significantly lower than those of the dry season but this is easily explained by the reduced visibility when woodland tree canopies are in full leaf. The distributional data associated with these estimates show that buffalo are more widespread in the wet season than during the dry season when water restricts the daily movement (**Fig.16** on page 30). ULG (1995) note that this effect is most pronounced along the Kwando and Linyanti Rivers but is also present within the Okavango delta where water is widely available throughout the year.

This observation suggests that movement between Botswana and the Caprivi is likely to be at its lowest during the dry season and, therefore, the dry season estimates for the Caprivi are indicative of the size of the "permanently resident" buffalo population.

To a limited extent, the lower estimates for the Botswana population during the wet season could be attributed to movements into the Caprivi. However, (1) there are no survey data for the Caprivi during the peak of the wet season to confirm this hypothesis and (2) the estimates of buffalo in the Caprivi are so small compared to the overall size of the Botswana buffalo population (see Fig.15) that it does not seem reasonable to conclude that emigration from Botswana could account for the lower Botswana wet season estimates.

ULG (1995), in considering the results from 1988 to 1995, presented a regression to show a significant downward trend in the population. This deduction was supported by an apparent shrinkage of range. However, the high estimates from 1999 and 2001 suggest that no such

6. Dr Danie Pienaar (pers.comm.) saw a herd of some 200 buffalo at a pan near the Luiyana River in Angola in 1989 not far north of the Caprivi Strip.

conclusion should be reached yet.

The population of buffalo in north-western Zimbabwe is secondary to the Botswana-Namibia linkage and the survey results are only presented in the context of a long term vision for a trans-frontier conservation area where buffalo populations are able to move freely between Botswana, Namibia and Zimbabwe. The realities of the present situation are that although veterinary control fences do not prevent movements of Zimbabwe buffalo westwards into northern Botswana,[7] only minor excursions have been recorded during the wet season. This may be because the physical gap between the international boundary and the nearest permanent water supplies in Chobe National Park is sufficiently large to deter most movement. Beyond that, the access for Zimbabwean buffalo to the eastern end of the Caprivi is barred by relatively dense human settlement.

Sample count aerial surveys have been consistently and regularly carried out in north-western Matabeleland area of Zimbabwe since 1980 and the past 10 years of results from Hwange National Park and Matetsi Safari Area are presented in **Table 5** below.

Table 5: Buffalo population estimates for north-western Zimbabwe

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Hwange NP	8,572	29,142	4,965	3,237	1,415	1,840	2,373	3,167	8,122	No Survey	6,663
Matetsi SA	1,279	16,893	6,824	822	3,674	1,942	5,290	1,830	11,207		6,693
TOTAL	9,851	46,035	11,789	4,059	5,089	3,782	7,663	4,997	19,329	–	13,356

These data indicate clearly the very large fluctuations which are possible from one survey to the next on the same population which is unlikely to have altered by more than 10% from one year to the next.

The results of aerial surveys which have recorded buffalo in Namibia are shown in **Table 6** on the following page and plotted in **Fig.16**. The table is based on the information in DSS (2002a) but has been updated with additional information from Rodwell (*et al* 1995), ULG (1994) and Craig (1998). The following observations apply to the data –

(1) The mix of survey techniques (sample surveys, total counts and actual sightings) preclude comparisons across the full data set;

(2) No confidence intervals are given for the sample surveys in DSS (2002a);

(3) Despite the apparent plethora of data, there are few complete surveys of the entire Caprivi in any single year; and

(4) The variation in the strata used within the Caprivi from survey to survey further reduces the value of comparisons.

7. Except in the extreme south-western corner of Hwange National Park where the international boundary fence has caused the deaths of a large number of buffalo.

Table 6: Estimates of Buffalo Populations in Namibia

Time of year when surveys were done

ED - Early Dry (Apr-June)		LD -Late Dry (Jul-Sept)	
EW - Early Wet (Oct-Dec)		LW - Late Wet (Jan-Mar)	

Type of survey

Standard Sample Survey
Actual sightings, Total count, *Unknown*

	Bushmanland & Nyae-nyae Conservancy	CAPRIVI							
		Mahango	Buffalo Area	West Caprivi	East .Caprivi	Mamili	Mudumu	TOTAL	NOTES
1977	1								
1978	2				8			8	EC: East of Kabe only
1979	2				0			0	
1980	0				**1,071**			1,071	
1980					*236*	*0*	*621*	857	*In: Rodwell et al (1995)*
1981				19				19	
1982					549		170	719	
1982					*150*	*217*		367	*In: Rodwell et al (1995)*
1983		0			80		0	80	
1984	40				185	8	0	193	
1985		3	*200*	175	45	228	0	651	*In: Rodwell et al (1995)*
1985				93				93	WC Doppies area only
1986		2		70	74	132		278	WC Doppies area only
1987		11	220	250	252			733	
1987			*250*					250	*In: Rodwell et al (1995)*
1988		120		0	237			357	
1988	7				24	515		539	EC St Michel only
1989		207	0	7	140	634		988	
1990	0	15	307			766	0	1,088	
1991		4						4	
1992		**64**						**64**	
1993		4	380	656		625	0	1,665	
1994			**401**	**950**		**1,173**	**2**	**2,526**	Rodwell et al (1995)
1994		288		1,351			**2**	1,641	
1994		–	**0**	–	**0**	**3,018**		**3,018**	ULG (1994)
1995	**0**	**2**				**2,523**	2	2,527	
1996								0	
1997								0	
1998	**0**		**33**	**422**		**103**	**0**	**558**	
1998	**33**	**98**			**0**	**104**	**324**	**526**	Craig (1998)
1999								**0**	
2000	**0**	**500**						**500**	

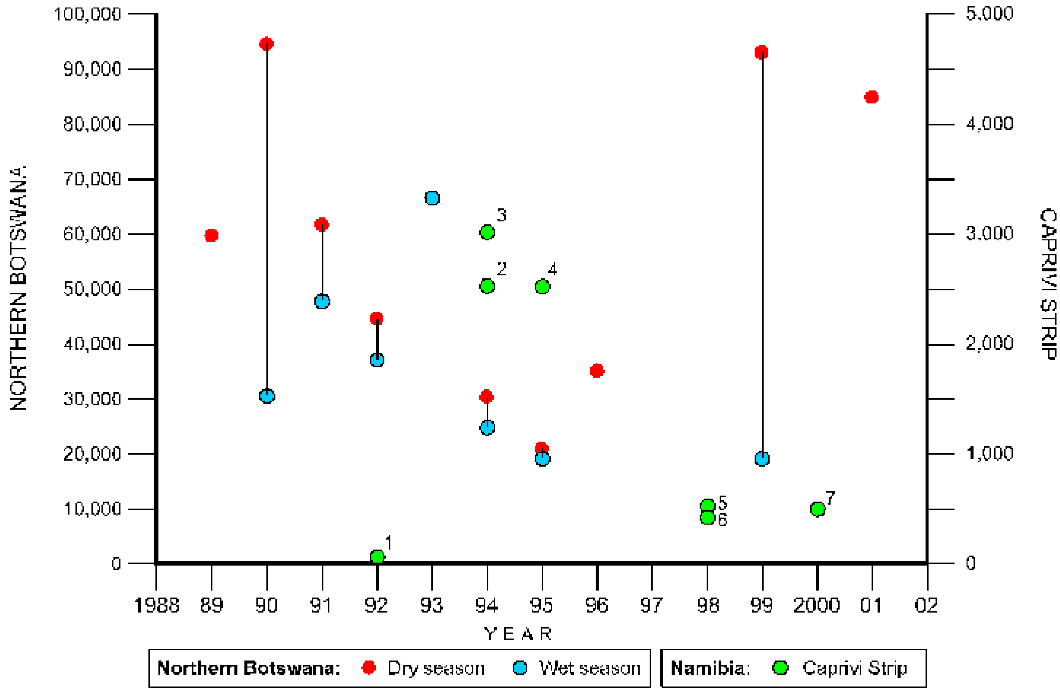

Figure 16: Aerial census results from northern Botswana and the Caprivi

Notes on the Namibian data points

1. Partial Survey 1992
2. Survey by Rodwell (*et al* 1995) in September 1994. Strata did not include Mahango NP in Western Caprivi and included only Madumu NP and Mamili NP in Eastern Caprivi.
3. Survey by D.St.C Gibson in 1994. Strata did not include Mahango NP or central part of Western Caprivi.
4. Survey in August 1995 reported in DSS (2002a).
5. Total result of surveys reported individually in 1998 in Caprivi in DSS (2002a). The result appears suspiciously similar to the survey below but certain strata do not match.
6. Survey by G.C. Craig in 1998 covering the full Caprivi.
7. Survey of Mahango only in September 2000 reported in DSS (2002a).

Bearing in mind the very large confidence intervals associated with the population estimates, the data in Table 6 and Figures 15 & 16 allow the following observations –

(9) The Botswana population is nominally some 90,000 animals in 150,000km^2 – an average density of 0.6 animals/km^2. This is consistent with the carrying capacities based on rainfall shown in Fig.7 on page 15. Over most of the Botswana range densities should lie between 0.5 and 1/km^2, with possibly higher concentrations in the extreme north-east adjacent to the Caprivi (1-2/km^2).

(10) The distributional data of DWNP (2000b) show the marked concentrations of buffalo

herds in the dry season in the Okavango Delta and along the Chobe and Linyanti Rivers. In the wet season, the herds are widely dispersed (**Fig.17** on the next page).

(11) ULG (1995) recognise 4 subpopulations within the main Botswana buffalo population: (a) the Kwando subpopulation; (b) the Delta subpopulation; (c) the Chobe subpopulation; and (d) the 'Border' subpopulation (the Botswana-Zimbabwe border). It is not obvious from their distributional maps whether these subdivisions are based on home range characteristics or whether they are simply an artifice for partitioning hunting quotas over the full buffalo range.

(12) The Namibian data indicate a resident population in the Caprivi of the order of 1,000 - 3,000 animals. Nothing in the data of Table 6 suggests any marked influx of animals from Botswana at particular times of the year and this is unlikely to be demonstrated until (a) a survey is carried out at the peak of the wet season and (b) a modified survey technique capable of more accurate and precise buffalo population estimates is devised.

(13) The distribution of buffalo in the Caprivi (Fig.14) indicates how critical for the Namibian buffalo population are the linkages with the Botswana population –

(1) The subpopulation in the west of the Caprivi (Mahango and the western "Core Area") is effectively isolated from other buffalo in the Caprivi by the inimical nature of the terrain in the central part of the Caprivi Game Reserve (primarily an absence of water) and it is also effectively isolated from Botswana by the veterinary fence along the international boundary.

(2) If settlement and subsistence agriculture continues to develop in the vicinity of the Kwando River in Namibia as described on page 24, the buffalo populations in Mamili, Mudumu and the western "Core Area" of Caprivi Game Reserve will become isolated subpopulations linked only through Botswana.

(3) If the Salambala Conservancy is ever to maintain a sustainable buffalo population, it will come about through colonisation from Botswana across the Chobe River rather than through any eastwards migration of buffalo from Mamili or Mudumu.

It is emphasised that the linkages with Botswana are needed more for the avoidance of isolated subpopulations within Namibia than for the augmentation of numbers of buffalo in the Caprivi. The land areas and potential range sizes for buffalo within the Caprivi are large enough for viable populations to be developed under the normal growth rates of the existing buffalo population.

In the next part of this examination of buffalo numbers, some potential carrying capacities for buffalo in the Caprivi are presented together with expected times to achieve them.

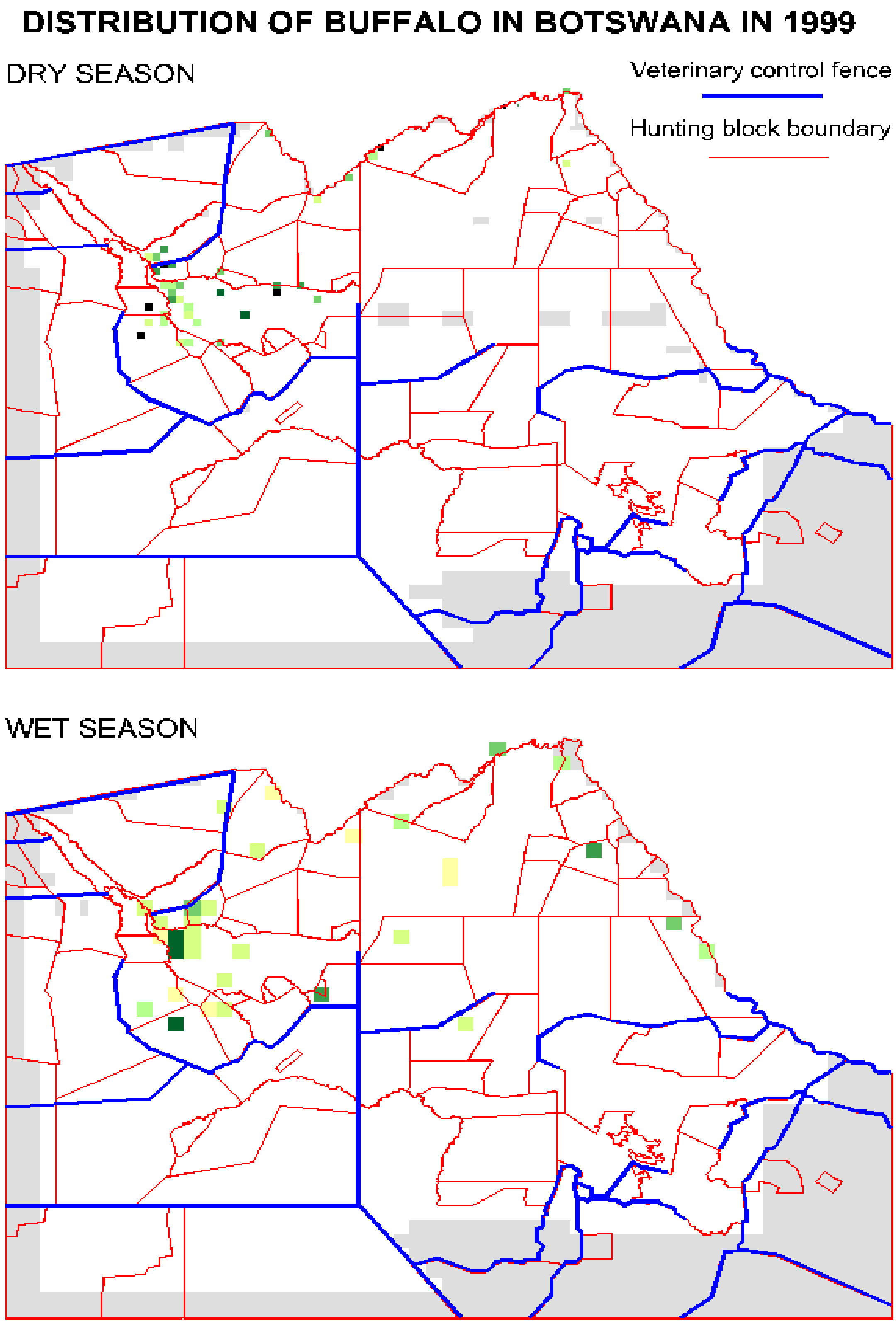

Figure 17: Wet and dry season buffalo distribution in northern Botswana and the Caprivi

I attempt here to make some projections of the levels which the Caprivi buffalo population might achieve and how long this process might take without any immigration from neighbouring countries (**Table 7** below). The steps entailed are –

a. The range data presented in the table on page 24 is reproduced here (using the more detailed estimates for range size).

b. The relationship between carrying capacities and rainfall developed on page 12 predicts that under a range of rainfall from 500-700mm as experienced in the Caprivi (Mendelsohn and Roberts 1997, p6), buffalo densities at carrying capacity will lie between 1-2 animals/km^2. I have used the upper limit of this as the target density for the core areas within the buffalo range (column 2 of the table). Thus in the core areas (5,000 km^2) the population could reach some could reach some 10,000 animals.

c. In the "medium range" I have assumed that buffalo would be unlike to reach the same levels as in the protected areas because of poorer habitats and human influences. A ceiling density of 1.2 animals/km^2 has been selected – partly because it rounds numbers off conveniently at an additional 5,000 animals. In the "maximum range" I have halved the density because the same factors would act increasingly to preclude the population reaching the core area levels. This gives a further increment of 5,000 animals.

d. The cumulative population reaches some 20,000 buffalo when the additional range increments are added. In this utopian situation, the Caprivi would be carrying one buffalo per square kilometre – which is by no means an unrealistic density if habitats and rainfall alone were to be considered.

e. The population growth rate which might reasonably be expected for the same rainfall is about 5% per annum (page 11). Starting with 3,000 buffalo in the "core areas" in the year 2003, it would take about 25 years for the population to reach 10,000 animals at this growth rate. Using the same starting population and growth rate, the "medium range" would reach 15,000 animals after 33 years and the "maximum range" would reach the level of 20,000 animals some 6 years later. Any immigration from Botswana would 'speed up' the process.

Table 7: Potential Buffalo Population in the Caprivi

BUFFALO RANGE	Area km^2	Ceiling Density N/sq.km	Final Buffalo Population	Rounded Numbers	Cumulative Population	Years to reach this level
1. "Core areas"	5,250	2.0	10,500	10,000	10,000	25
2. "Medium Range"	3,982	1.2	4,778	5,000	15,000	33
3. "Maximum Range"	8,285	0.6	4,971	5,000	20,000	39

The scenario for the "Core Areas" is eminently realisable. The remainder assumes that policies, practices and incentives which are very favourable for buffalo to come into effect!

To complete this section on buffalo numbers in Namibia, two small captive populations of Foot and Mouth disease-free buffalo need to be recorded.

Waterberg Plateau Park

The introduction of 48 buffalo took place between 1981 and 1991 at an average rate of 5 per year over this period (Erb 1992). Most of the animals came directly from Addo National Park in South Africa although 11 came from from Willem Pretorius Game Reserve in the Free State in 1985-86 (presumably these animals originated from Addo stock) and 4 were buffalo of East African origin imported from a Czechoslovakian Zoo in 1986. The last estimate for the present population was 184 in the year 2000.

I have used the population model developed on page 10 to examine the implied rates of growth of the population. Setting the various parameters in the model for a rainfall of 400-500mm and beginning with a starting population of 48 animals biased in favour of females and with few juveniles, the results are shown in the table opposite. The correspondence with those counts carried out in the park for which data is to hand is very close. It is to be expected that the initial growth rates will be high whilst the population is small and the age structure highly skewed. The growth rate starts to decline after 1998 and in the very long term (50 years) levels off at 4.2% when the age structure is stable.

Year	Park Count	Model predictions	
		Number	Rate of growth %
1988	44	67	9.8
1989	72	73	9.0
1990	72	79	8.2
1991	88	86	8.9
1992	104	94	9.3
1993		104	10.6
1994		115	10.6
1995		128	11.3
1996		141	10.2
1997		156	10.6
1998		173	10.9
1999		189	9.3
2000	184	205	8.5
2001		221	7.8
2002		239	8.1
2003		258	8.0
2004		279	8.1
2005		300	7.5

This prediction ignores the carrying capacity of the Park. With an annual rainfall of about 500mm, the sustainable density of buffalo is about $1/km^2$, i.e. some 400 animals for the Park. This ceiling will soon be reached and it can be expected that both habitats and buffalo will deteriorate in the future if remedial measures are not taken.

Tsumkwe

The origin of the Tsumkwe buffalo was mentioned on page 18. In 1996 thirty buffalo were penned in a quarantine camp in Bushmanland (within the Nyae Nyae conservancy) which is north of the main veterinary cordon fence (Fig. 12 on page 22). One animal was destroyed because it tested FMD positive but the present herd of 68 animals is remarkably free of the various diseases listed in Table 3 on page 19 and is commercially very valuable. However, in the low rainfall conditions of Tsumkwe where the carrying capacity is well below 1 buffalo/km^2, the present population of 68 animals in 2,400ha is grossly overstocked (i.e. $3/km^2$) and is having to receive supplementary feeding.

The various management options for these and the Waterberg buffalo are discussed in the final section.

2. Behaviour

Several behavioural attributes of buffalo have already been touched upon in the preceding sections and therefore this discussion will be kept brief.

A number of observers including Sinclair (1977) and Taylor (1985) have observed the seasonal subdivision of buffalo herds. Buffalo tend to form large herds in the wet season when food is abundant and separate into small herds when food is scarce in the dry season. Sinclair (1974a) found that buffalo in the Serengeti showed no habitat preferences in the wet season – all habitats are equally suitable when food is plentiful. Taylor (1985) observed that when the large herds at Matusadona dispersed inland in the wet season, bachelor male groups remained on the lakeshore and were thus able to occupy the most favourable habitats the year round. Females, on the other hand, are forced to travel further within their home range in search of food because of the nutritional burden placed on them by nurturing calves and moving in large herds.

Sinclair (1974c) found that the amount of time which buffalo spent on feeding remained fairly constant throughout year and, during the wet season, there was no pattern of daily activity cycles. In the dry season daily cycles of activity became more pronounced: buffalo spent little time grazing in the hottest part of the day and devoted longer periods to ruminating when food quality was poorer. Much of this behaviour demonstrates adaptations aimed at reducing energy expenditure when food is limiting. Buffalo are selective grazers in the wet season but this behaviour creates difficulties for them in the dry season when little is left of their preferred species.

Instances of intra-specific aggression are observed amongst buffalo males often resulting in animals being expelled from herds. However, male mortality is no worse than female mortality and Sinclair (1974b) concluded that social stress did not appear to cause mortality directly. Since food shortages affected all age groups of both sexes equally, mortality could not have been socially induced. Buffalo are regulated more by undernutrition than any social factors.

Both inter-specific and intra-specific competition for food are the ultimate factors regulating buffalo populations. Sinclair (1974c) made the definitive statement that buffalo populations are regulated by adult mortality caused by undernutrition as a result of food shortage. Food shortage, in turn, is caused by intra- and inter-specific competition.

Sinclair makes the important point that a population of any species is effectively competing with another species if it eats any of the food of required by that species. If the population of one species is large it can have a marked impact on the smaller population of the other species. In the Serengeti, wildebeest were in large numbers and were responsible for depleting the resources of buffalo. It may well be that the very large elephant population in northern Botswana and the Caprivi are competitors with buffalo – both are wet season grazers.

Buffalo appear to waste little energy in competing for territory. Although Taylor (1985) found non-overlapping home ranges amongst large buffalo herds, the numerous observations of long distance buffalo movements suggest that territoriality is secondary when it comes to securing bulk food resources. The best strategy for buffalo may not be to compete for territory but to use resources as fast as possible when they are abundant.

g. Limiting Factors

I conclude this section with a summary of those factors which appear to be important in determining buffalo abundance in the project area. A considerable amount of effort has been devoted to examining the biological aspects of the buffalo (largely because the terms of reference required it) and this work has been both interesting and valuable – in the sense that it has allowed an understanding what performance might be expected of Namibia's buffalo population under "natural" conditions.

Firstly, **abiotic factors** play a major rôle in determining the numbers and distribution of buffalo in the project area.

(1) It has been shown that **rainfall** is the primary driving vector which affects –

  (1) the overall carrying capacity of land for buffalo through food production;

  (2) the fecundity of female buffalo through levels of nutrition; and, hence,

  (3) the maximum growth rate of buffalo populations; and

  (4) the amount of surface water available to buffalo: notwithstanding any food production as a result of good rainfall, habitats mat be rendered unavailable to buffalo if there is insufficient surface water.

(2) To a secondary extent, soil fertility influences overall food production.

(3) Recalling the primary habitat requirements of buffalo given on page 3, temperature is a determinant of buffalo behaviour in that they are obliged to seek shade whenever temperatures exceed a certain threshold.

Of the **biological factors** which might be expected to exert an influence on populations –

(1) <u>Predation</u> is a relatively minor factor – in the words of Sinclair (1974b), its "effect is swamped by other factors";

(4) With the exception of rinderpest, the effects of the various <u>diseases</u> to which buffalo are susceptible (page 19) are also relatively minor. Together, predation and disease tend to be secondary factors acting on undernourished animals (Pienaar 1969). Disease may differentially affect juveniles but the resultant mortality is likely to cause population fluctuations rather than any substantive long term alterations to basic population growth rates (Sinclair 1974b). Rinderpest an exception – the whole population is affected.

(5) The point was made in the previous section that most savanna <u>habitats</u> are suitable for buffalo providing rainfall is adequate. Buffalo are regulated by their food supply – more particularly, it is the decline in quality and quantity of available food below the minimum maintenance level required by buffalo during the dry season that limits the population (Sinclair 1975).

(6) A biological factor which may be significantly affecting buffalo abundance in the project area is the large elephant population in northern Botswana and the Caprivi. As pointed out in the previous section (page 35), competition for food is the ultimate determinant of carrying capacities.

Coe, Cumming and Philipson (1976) noted that it was a distinct characteristic of large mammal communities in savannas over much of Africa that, although many species might contribute to the cumulative biological diversity in any area, the major biomass contribution would be made by a limited number of species. Often the entire large mammal community would be dominated by two or three species e.g. elephant and buffalo. This is the situation one would expect in the project area. The fact that it is not present in the Caprivi gives cause for ponder.

The ecological factors with a potential effect on buffalo are quite secondary to the **human-induced factors** in this situation.

(7) Although there is undoubtedly a high level of illegal hunting in the project area (in parts of Angola this hunting may be totally unsustainable), this may less important than the factors which follow. The illegal hunting is carried out in situations where the higher-valued uses of buffalo cannot be realised due to lack of empowerment over natural resources, the failure to develop management institutions and a lack of incentives for conservation.

(2) Veterinary control measures are probably the single most important determinant of buffalo distribution and numbers within Namibia and across the entire subregion. Large parts of the potential range are not available to buffalo and within the allowed range many populations are becoming totally isolated as a result of the placement of fences.

(8) Within the Caprivi and northern Botswana, the *de facto* location of human communities and their cattle not only dictates the application of veterinary measures but also results in direct competition with buffalo for land and grazing resources. This is a competition which buffalo are unlikely to win. The present available range for buffalo is determined by patterns of human settlement, the amount of land cleared for agriculture and the grazing requirements of cattle.

In preparing the numerous maps for this first main section of the report, it is difficult not to be aware of the major planning deficiencies which have characterised land allocation in the project area. Far from being proactive, governments have tended to respond to the dictates of haphazard settlement and make cosmetic alterations to *de facto* situations. In the next main section the comparative value of land use where buffalo are a major component of wildlife systems is examined – with the conclusion that planning has done little to achieve optimum land use .

2. CONSERVATION SIGNIFICANCE

The Taxon Data Sheet of IUCN's (1997) Conservation Assessment and Management Plan (CAMP) has been completed for the southern savanna buffalo (**Appendix 1**). The data sheet is intended for the global population of the species but, for those aspects which relate to management and conservation of buffalo in this project area, I have answered the questionnaire appropriately. My personal reservations as to the value of the exercise are contained in comments following the questionnaire.

Under the IUCN Red Data Book system, the Southern Savanna subspecies of buffalo *Syncerus caffer caffer* is classified as "Lower Risk (conservation dependent)" by the Antelope Specialist Group (ASG 1998) and it is evident from the data on the Taxon Data Sheet that the subspecies cannot be regarded as threatened in any global or regional context. Even at the national level, the Namibian buffalo population cannot be considered "vulnerable" under the criteria: although its 'extent of occurrence' in the Caprivi is less than 20,000 km^2, within that range its 'area of occupancy' is greater than 2,000 km^2. Because it is linked to the large Botswana buffalo population, it would not qualify for any category of threat based on population numbers.

Perhaps the greatest danger to the Namibian buffalo population is the potential fragmentation which could arise if links were severed with the Botswana population due to injudicious application of veterinary control fencing or the spread of settlement and subsistence agriculture within the Caprivi – resulting in the isolation of subpopulations.

It is difficult to argue on conservation grounds that more buffalo are needed in Namibia. It is disappointing that there are no buffalo in the main body of the country where they were once common. However, their functional role as bulk grazers in ecosystems has been taken over by cattle and this is perceived by many landholders and veterinarians as advantageous. In large State Protected areas, such as Etosha Pan, their absence does not result in ecological problems because the aridity of the ecosystem does not seem to require more than the existing complement of grazing animals. The facilitation rôle which bulk grazers play in more mesic systems is less vital here. In the Caprivi buffalo are not on the verge of extinction and it is difficult to argue a case on conservation grounds why there should be more.

It is also doubtful whether the presence of buffalo would cause any marginal increase in non-hunting tourism income in the main body of the country. Tourists that visit Namibia are primarily seeking a combination of landscape values and arid ecosystem wildlife viewing, and are unlikely to be turned away by the knowledge that buffalo have become extinct in the north in recent times. In the Caprivi, if buffalo were more abundant it would hardly affect game viewing potential in the parks or conservancies.

There is one realm where the abundance of buffalo is significant and that is in international sport hunting. Buffalo are a key species in the safari hunting industry. The value of a single buffalo trophy is secondary to the economic activity which can be generated around that buffalo.

To explore the financial and potential land use rôle of buffalo, two scenarios are examined in this study –

(1) If the numbers of buffalo in the Caprivi could be increased to a level close to the maximum carrying capacity, what would be the impact on safari hunting income ? and

(2) If buffalo were introduced to commercial farms in the northern areas of Namibia (south of existing veterinary cordon fences), what would be the impact on land use?

(1) Sport hunting in the Caprivi

(1) Estimates of the numbers of wildlife species in the Caprivi are given in Table A of **Appendix 2**. Since most of these animals occur in the 'core wildlife range' of about 5,000km^2 (page 24), the financial modelling for sport hunting, in the first instance, is limited to this range.

(2) In Table B of Appendix 2, I develop a hypothetical community of species populations which might be expected in 1,000km^2 of the Caprivi 'core area' at 'carrying capacity'. The existing population estimates are used as a guide only because most of the smaller species are grossly underestimated in air surveys. I have relied more on the relative proportions of the species and assigned a typical density for each species at carrying capacity under an annual rainfall regime of 500-600mm. The numbers in 1,000km^2 have then been adjusted so that the overall stocking rate, including a buffalo population fixed at a density of 1.5 animals/km^2, amounts to 10 hectares/LSU equivalent which is a reasonable level for the rainfall. In the final column of Table B, hunting quotas are set for each species. From Table B onwards, all of the tables in Appendix 2 are linked so that it is possible to explore the effects of changes in any species population or hunting quota.

(3) In Table C, species are grouped and ranked according to their approximate hunting trophy value. The total value in trophy fees for this model wildlife population is about US$800,000 of which the buffalo quota contributes more than a quarter.

(4) In Table D the quota is 'packaged' into different types of hunts aimed at maximising the income possible from the available animals.[8] The hunts are arranged in order of decreasing value. The gross financial return from the hunting is US$1.3 million (US$13.14/ha) of which trophy fees contribute about 60%.

(5) In Table E the process is repeated but without the high buffalo numbers. Buffalo densities have been set at 0.25/km^2 which is typical of the present numbers in the Caprivi outside the State protected areas but still within the core range. With the reduced buffalo population, the gross income/hectare drops to US$9.05/ha. The reason it is not lower is because of the value of the large elephant quota.

(6) The annual operating costs for a safari operator are calculated in Table F. Because the hunting quota for 1,000km^2 generates about 720 hunting days and because, in order to

8. The packaging process is entirely automated within the table using Boolean logic.

be viable, a safari operator needs about 180 hunter days/year, the costs are calculated for a single camp hunting operation in 250km^2. Four such concessions would take up the total quota for 1,000km^2. The capital costs of setting up the operation are included in the operating costs by depreciating the capital over 5 years and recovering one-fifth of the cost each year. The operating costs are about US$4.37/ha.

(7) The final outcomes are given in Table G of Appendix 2 which is repeated as **Table 8** below. The total 'core range' for buffalo in the Caprivi is about 5,250km^2 (see page 33) and, if the protected areas where hunting is not possible are deducted from this, the safari hunting model would apply to an area of about 4,000km^2 .

Table 8: The effect of an increased buffalo population on sport hunting income in the core range of the Caprivi.

	WITH PRESENT BUFFALO DENSITY	WITH BUFFALO AT CARRYING CAPACITY
Area	4000 km^2	4000 km^2
Buffalo Density	0.25/km^2	1.5/km^2
Gross income US$/hectare	9.05	13.14
Operating costs US$/hectare	4.37	4.37
Net income US$/hectare	4.68	8.77
Potential earnings from 4,000sq.km	1,872,680	3,506,680

The results of this speculative analysis indicate that the present value of sport hunting in the core range of the Caprivi would roughly double (present net income US$4.5 million; possible income US$9 million) if buffalo densities could be increased to 1.5/km^2 – which is by no means a 'tall order'. The preceding analyses suggest that a density of 2/km^2 is feasible in the core range.

What of the remainder of the potential range in the Caprivi ? Taking the range data of Table 7 and applying the same methodology (including increasing the density in the core range to 2/km^2, the results are –

BUFFALO RANGE	Area km^2	Ceiling Density N/sq.km	Net income US$/ha	Net income US$
1. "Core areas"	4,000	2.0	10.6	4,240,000
2. "Medium Range"	4,000	1.2	7.7	3,080,000
3. "Maximum Range"	8,000	0.6	5.7	4,560,000
			TOTAL NET INCOME . . . US$	**11,880,000**

This is speculative in the extreme and does not really provide comparative data for the relative effects of an increase in buffalo in the remainder of the range. For the projected earnings from the 'medium range' and 'maximum range' to be realised it would require all other wildlife species to increase concomitantly and it no longer becomes sensible to consider values with and without buffalo. However, what these data do suggest is that if buffalo were to become the economic engine which led to higher valued land use in the core range, there are strong incentives for developing the medium and maximum range under wildlife management because the potential earnings are many times higher than all alternative land uses.

This analysis could have been performed in many different ways. The amounts set for trophy fees and for daily rates are not independent and are very much up to the individual operator. The hunting client will take into account the combination of both in choosing a safari (i.e. the 'bottom line'). However, the prices which have been used are representative of the sport hunting industry in southern and central Africa.

To some extent, the value of the increased buffalo population is obscured by the presence of a large elephant population which equally valuable in the safari hunting industry. The difference between having a large and a small number of buffalo would be far greater were it not for the elephant – as it is in the next scenario to be examined (the commercial farming areas).

Several observations need to be made on this analysis. It is a relatively simple financial exercise with no pretensions to being a full economic analysis. Barnes (*et al* 2002) analysed the expected performance from Mayuni and Salambala Conservancies in the Caprivi (see table below). Their analyses were 'primarily *appraisals* of conservancy development plans and projected incomes, rather than *ex post evaluations* of past conservancy performance.' and this has to be borne in mind in using the data for comparative purposes. Also, a feature of the community analysis is the fact that 'donors, and not the communities, bear many of the initial capital and recurrent input costs. All conservancies benefit from donor assistance in this way.' The data which are directly relevant to this study are the capital inputs, the cash incomes per hectare and the financial and economic rates of return.

Value	Mayuni	Salambala
Project financial values	US$	US$
Initial capital investment	107,909	198,605
Capital investment per ha.	3.78	2.10
Community financial values		
Annual community cash income	102,579	59,648
Cash income per household	228	50
Cash income per ha.	3.64	0.64
Financial rate of return	220%	40%
Economic values		
Net value added per ha.	4.1	0.7
Economic rate of return	126%	31%

In this model, very little capital has been employed to realise the returns: the safari operator's annual capital investment of US$0.93/ha/annum (Table F, Appendix 2) realises a net income of US$8.77/ha. This would produce far higher financial and economic rates of return than those shown in the table.

All costs and income have been internalised within a safari operator's budget. The apparent profit of US$8.77/ha (a 100% profit margin for the operating cost of US$4.37/ha) would not, of course, accrue to the operator. This is the sum from which all community income would be derived and it is obvious that a very large surplus would be available. If the safari operator were left with a 50% profit on operations (US$2.20/ha),[9] the balance available for community income under any form of joint venture or concession rental would be US$6.69/ha. This is almost double the projected cash income for Mayuni in the table above and even more than that for Salambala.

The conclusion to this analysis is that buffalo have the potential, through their value in the sport hunting industry, to raise the overall value of net income from land to almost double that from existing wildlife uses if their numbers can be increased to carrying capacity. As the existing wildlife uses are financially and economically more profitable than subsistence agriculture and cattle husbandry, the potential rôle of buffalo in a land use context is very significant.

(2) Buffalo as a Component of Sport Hunting on Commercial Farms in Northern Namibia

(1) Estimates of wildlife numbers on commercial farms throughout Namibia (Barnes and de Jager 1995) are given in Table A of **Appendix 3**. Because of rounding errors, rather than develop a wildlife population for a single farm (about 60km^2), the numbers have been set for an area of 1,000km^2 (about 17 farms).

(2) Using average wildlife densities for the whole of Namibia will tend to underestimate wildlife numbers on those farms which have invested preferentially in wildlife. To correct for this, the numbers in 1,000km^2 have been scaled up by a factor which results in an overall stocking density of 1LSU/20ha – a value which is reasonable given the rainfall regime (Barnes and de Jager 1995, page 3). The 'model population' (Table B) includes 500 buffalo at a density of 0.5/km^2 which is a conservative stocking rate appropriate for an annual rainfall of about 400mm.

(3) Sport hunting quotas have been set for this model population and the value of the quotas is given in Table C based on the data of Himavundu (2001). Species have been grouped into categories of similar value and some adjustments have been made to trophy values where a particular species is considerably above the regional average.

(4) The total quota has been packaged into individual hunts aimed at maximising the possible income (Table D). At typical daily rates for hunting, the quota should yield a gross income of about US$6.27/hectare and should generate some 600 hunter days in 1,000 km^2. Without buffalo the gross income is reduced to US$4.65/ha (Table E).

(5) Fixed and variable costs have been taken from Barnes and de Jager (1995) and scaled up for cost increases since 1995 giving a total operating cost of US$5/ha. In the case with buffalo (Table D) this results in a net return from the land of about US$1.27. Without buffalo (Table E), hunting operations run at a loss of some US$0.35/ha.

9. Due to intense competition in the safari hunting industry in southern Africa, few safari operators are realising profits of 50% – far more common are margins below 20%.

Barnes and de Jager (1995, page 10) remark that "Ranches in Namibia have low profitability". They examined the financial and economic viability of cattle/game ranches in northern Namibia and found that on ranches of less than 10,000 ha, typical gross incomes were of the order of US$7.6/ha and net cash incomes were US$1.08/ha. On larger scale conservancy operations (100,000ha) fixed costs per unit of land decrease and the net income rises accordingly to slightly more than US$2/ha. Unfortunately, these results are not directly comparable because of the inclusion of a substantial cattle population – 75% of the total biomass in their models was made up of cattle. Of note is the fact that both the financial and economic rates of return from the large scale operations were found to be positive.

To a large extent, the question of profitability from these operations is relative. The question which was posed at the outset was whether the presence of buffalo would make a significant difference to the viability of ranching operations in northern Namibia. All other things be equal, buffalo increase the gross income from land by some US$1.62/ha or 35%. If the real operating costs were as stated, the inclusion of buffalo in wildlife hunting operations on typical marginal land in northern Namibia makes the difference between a net profit and a net loss. If the assumption is made that operating costs are slightly lower (e.g. the figure of US$4.37 used in Appendix 2), then the operations without buffalo run at a break-even level and the inclusion of buffalo results in a net return of US$2/ha from the land.

The results of Barnes and de Jager (1995) suggest that, under present circumstances, there is little financial incentive for individual farmers practising livestock and game production systems to convert to pure game production either for consumptive or non-consumptive use. Their results clearly show that production at a larger scale within conservancies is likely to be more efficient both financially and economically than production at a ranch scale. Safari hunting on private land appears to have been profitable but only as a supplementary enterprise alongside livestock or other wildlife land uses. Its profitability appears, on livestock farms, to have provided the financial incentive for much investment in wildlife and this, in turn, has led to conditions where pure wildlife ranching is possible.

Barnes (*et al* 2001) state that in the medium to long term the comparative advantages of land use based on domestic livestock can be expected to decline as international subsidies are phased out. They also point out that the comparative advantages of wildlife land uses can be expected to increase over time, due to continuing rapid expansion in international tourist markets, increasing scarcity of wildlife elsewhere, and the development of markets to capture international wildlife non-use values as income. Their results show that commercial livestock ranching has limited potential to compete economically with wildlife use because it is capital intensive and requires access to external markets.

The findings from this study indicate that, under land use systems which are inherently disadvantaged by low rainfall and cannot expect net returns of more than a few US dollars per hectare, the inclusion of buffalo in the wildlife population would have a dramatic impact.

I conclude this section with some more general observations on the wildlife industry.

In the development of the wildlife sector, non-consumptive tourism on high quality wildlife land will give by far the greatest economic returns (Barnes 2001, Martin 1999). However, only a limited amount of land in any country is suitable for high quality game viewing tourism and, if wildlife is to compete with alternative land uses over larger tracts of land, then it is necessary to harness a range of sustainable uses to maximise the income from wildlife. Safari hunting is one such use. Martin (1995) found that whilst high quality ecotourism could very easily realise net returns greater than US$25/ha, the net income values for safari hunting reached a ceiling of about US$7/ha. This may, in many situations, be the highest valued use for wildlife and the highest valued overall land use.

Safari hunting is capable of producing competitive returns from land with less capital investment than that required for non-hunting tourism and with a lower adverse ecological impact. It has other advantages. Whilst it may take several years for any non-hunting tourism venture to build up markets, the returns from sport hunting are almost instantaneous – provided a minimum population of wildlife is present. This feature may be very important in the development of local community wildlife programmes where benefits are needed from the outset in order to provide the incentives for wildlife conservation.

Barnes (*et al* 2002) observe that instability in markets for wildlife use activities can affect sustainability and give examples to show that recent political events in southern Africa have severely affected growth in non-consumptive tourism in parts of Namibia. In particular, tourism income was sharply reduced in some of the conservancies examined in their study. Safari hunting has been demonstrated to be far less susceptible to these types of market peturbations. It may be that the political instability to which Barnes (*ibid*) are referring obliquely is the present traumatic situation in Zimbabwe. It is significant to note that whilst the Zimbabwe ecotourism market collapsed very shortly after the inception of the said ‘political events’, its safari hunting market has persisted throughout – albeit slightly reduced in volume in this 2002 hunting season. A similar situation existed during the ‘liberation war’ in the 1970s in Zimbabwe. Where there was no ecotourism activity to speak of, a viable and resilient safari hunting industry continued throughout the war. This consideration should affect decision-taking on land uses in the areas of this study.

3. STAKEHOLDING

a. Stakeholders

The term 'stakeholder' is often loosely applied and may include a range of parties whose so-called 'stakes' differ considerably in scale. For this reason it is essential to distinguish between various degrees of stakeholders and to base decisions on the magnitude of the 'stake' which each party brings to the table. The primary stakeholders who are affected by the occurrence, abundance or absence of buffalo in Namibia are landholders, including those with traditional landholdings. Secondary stakeholders are those who have a direct financial investment in the land and the wildlife industry. Tertiary stakeholders are those who have an interest in the conservation of buffalo but do not contribute financially to the process.

In the preceding section, it was necessary to examine the rôle of buffalo in two quite separate situations: the Caprivi, where the main buffalo populations occur, and the northern commercial farming areas where, at present, buffalo are absent. In discussing relevant primary and secondary stakeholders, this dichotomy should be maintained because the issues are very different. There is a third distinct group of stakeholders whose interests may differ from the first two and that is the group which currently holds populations of foot and mouth disease-free buffalo in the north east of Namibia. Each of these stakeholder groups are dealt with separately.

(1) The Caprivi

The two primary stakeholders are the State and the local communities. The individual State Conservation Areas are shown in Fig.14.

Land Category	Authority	Total Area km^2
State Conservation Areas	Ministry of Environment and Tourism	7,000*
Mahango Game Park	Directorate of Resource Management	200
Popa Game Reserve	" " "	20
Caprivi Game Park	" " "	5,500
Mudumu National Park	" " "	1,000
Mamili National Park	" " "	280
State Forest	Authority not designated	1,496
Communal Lands	Regional Governor	11,239
Kabe	Councillor, Communal Land Board	2,113
Katima Mulilo	" " "	1,960
Kongola	" " "	2,024
Sibinda	" " "	1,726
Mukwe	" " "	8,519
Linyande	" " "	3,667

* I have avoided giving detailed figures for the conservation areas here because of confusion over the

individual park areas (Mendelsohn & Roberts 1997, PW 1998).

In 1996, a legislative amendment provided for custodial rights over wildlife to be granted to communities on communal land subject to their forming and registering "*Conservancies*". The provision grants partial rights for common property management and use of wildlife in defined areas (Corbett and Jones 2000). By 2002, 15 conservancies had been registered, and some 35 more are in the process of being developed (Travel News Namibia 2002).

The Conservancies which have been established or are being established in the Caprivi are shown in Fig.14 and listed below –

Established: Kwandu (190km^2), Mayuni (151km^2), Mashi (c250km^2), Wuparo (190km^2) and Salambala (930km^2)

Proposed: Malengalenga, Lianshulu and Impalila

All of these are within the potential buffalo range, and the outcome for buffalo in the Caprivi depends critically on their success (page 37).

The secondary stakeholders in the Caprivi are those with a direct investment in the wildlife industry (tour operators and safari operators) and those organisations assisting to develop conservancy programmes which are listed below (Government agencies are omitted here because they have been listed amongst the primary stakeholders) –

Centre for Research Information Action in Africa - Southern Africa Development and Consulting (CRIAA - SA-DC)
Game Products Trust Fund
Integrated Rural Development and Nature Conservation (IRDNC)
Legal Assistance Centre (LAC)
Multipurpose Research and Consulting Centre - University of Namibia (MRCC-UNAM)
Namibian Association of CBNRM Support Organisations (NACSO)
Namibia Community Based Tourism Association (NACOBTA)
Namibia Development Trust (NDT)
Namibia Nature Foundation (NNF)
Namibia Non-Governmental Organisations Forum (NANGOF)
Rössing Foundation
Rural People's Institute for Social Empowerment (RISE)
World Wide Fund for Nature - Living in a Finite Environment Programme (WWF LIFE)

The large international donors which are investing funds in community based wildlife management in the Caprivi are not listed here, mainly because their investments tend to be directed through the organisations listed above.

Tertiary stakeholders would include various wildlife societies and individuals concerned for buffalo conservation and tourists who enjoy the recreational opportunities of the Caprivi.

(2) Northern Namibia Commercial Farms

Buffalo are perceived by some as a highly desirable component of land use systems and, equally, the reverse is true. Therefore those that oppose the introduction of buffalo to commercial farms in northern Namibia have to be regarded as stakeholders: whether they should be seen as primary or secondary stakeholders is a matter for debate. Perhaps those who are investing in wildlife development on land should be recognised as primary stakeholders and those who oppose the introduction of buffalo as secondary.

I will justify this inflammatory statement. There has been sufficient research to argue that on marginal land in southern Africa the highest valued and most ecologically beneficial land uses are those which rely on natural resources – more specifically in the case under discussion – wildlife. A number of relevant references have already been given in this report but it would be possible to compile a very long list of additional references supporting the conclusion. Those who are investing in wildlife development are following an established trend in southern Africa with strong justification for their actions. Those who are opposed to the introduction of buffalo do so on the grounds of a perceived threat to the viability of the cattle industry and, to a certain extent, the threat of diseases which affect other domestic livestock.

If a hypothetical situation existed where a single landholder wished to introduce a disease-ridden wildlife species into a farming community which was pursuing a thriving industry based on domestic livestock, it would seem very reasonable to reject the proposition. If the proposal came from a large group of potential investors it would have to be treated with more weight. The Directorate of Veterinary Services are at pains to point out that the decision whether or not to introduce buffalo to areas south of the "red line" veterinary control fence is not theirs but sits with the commercial farming community at large (Novall, pers.comm.10/10/02).[10] Obviously it will require a critical mass of would-be wildlife investors to sway the issue – but the nature of the democratic institution which these potential investors have to convince is arguable. The further away from the locality of a proposed buffalo introduction any particular livestock farmer is, the lower is the real threat to his livelihood. In a large country such as Namibia it is questionable whether any potential stakeholder in the extreme south of the country should have a say over land use activities in the north. There are many intermediate veterinary control solutions (Foggin and Taylor 1996) which would maintain protection against livestock disease for southern stakeholders whilst allowing northern farmers to hold disease-free buffalo.

Recent data from Botswana (J. Broekhuis, pers.comm. 16/10/02) shows that the wildlife industry is generating some 4½% of the gross national product from 40% of the national land – the cattle industry generates 3% from the remaining 60% of the land. Barnes (2001, Table 1) shows that commercial cattle farming in Botswana (which enjoys the same beef export status as Namibia) is capital intensive and suffers low profitability. Without government subsidies the annual net cash income/ha is about US$0.6 and the financial rate of return is negative when set against an 8% discount rate of money. So those seeking to add buffalo to wildlife systems cannot be said to be threatening highly profitable alternative land uses.

Some experience with the introduction of buffalo to commercial farms in Zimbabwe is directly

10. Deputy Director, Directorate of Veterinary Services, Ministry of Agriculture, Water and Rural Development.

relevant here. The following is quoted directly from Foggin and Taylor (1996) –

> "Whilst the establishment of FMD-free buffalo herds [478 buffalo on 21 commercial ranches in the veterinary 'clear zone'[11]] was highly innovative, it was clear that it would take a number of years before there were sufficient numbers of such buffalo to be of meaningful financial and economic benefit. Nevertheless, because of their value, there remains a great demand for buffalo on private land. The Department of Veterinary Services has been sympathetic towards the economic arguments put forward and, in consultation with the farmers concerned, drew up minimum fencing standards[12] to hold free-ranging buffalo on approved properties in FMD control zones.
>
> The decision was also based on epidemiological evidence that the airborne spread of FMD virus has never been demonstrated in southern Africa. Whilst presently limited [more than 1,000 buffalo which are not disease-free now exist on private land in FMD control zones on arid terrain similar to that of northern Namibia], this number of buffalo can be expected to increase. . . .
>
> With the growth of the economic importance of wildlife production as a form of land use, veterinarians have recognised the demand to accommodate the needs of the wildlife sector. This has been strengthened by the declining viability of cattle production and the prevalence of drought over the last decade. The need to re-examine land use in non-arable marginal land and the adoption of imaginative approaches to both animal production and disease control is emphasized. This is true for both commercial farm land and communal areas where wildlife is now making an important contribution to rural development."

Morkel (1988) identified suitable sites to which FMD-free buffalo might be introduced in the commercial farming sector and considered the buffalo from the Waterberg Plateau as suitable animals to introduce.[13] He also proposed the necessary veterinary precautions which would need be attached to the introduction.

The primary stakeholders in this particular instance are the commercial farmers in the Outjo, Tsumeb, Groofontein and Otjiwarongo districts and perhaps those in the north east of Okahandja and Gobabis districts.

Secondary stakeholders are those who are not landholders but who are investing in the development of wildlife-based land use in these areas. This group would include hunting outfitters, professional hunters, hunting guides, tourist lodge operators, businesses involved in processing trophies and, in general, all support systems for the wildlife industry.

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11. . . . which is the equivalent of the "Free Zone" in Namibia.
12. It is somewhat ironic that the specifications for these fences are exactly those used in the Namibian Veterinary Cordon Fence – indeed, it would be accurate to state that the idea was borrowed from the Namibians.
13. At the time Morkel gave his recommendations the Tsumkwe herd was not in place.

The tertiary stakeholders would be the same as in the Caprivi situation.

(3) The Waterberg and Tsumkwe FMD-free Buffalo

The final situation to be examined is the group of stakeholders associated with the two Foot and Mouth disease free herds of buffalo identified on page 34.

The primary stakeholder for the Waterberg Plateau population is the Ministry of Environment and Tourism since the buffalo occur on their land. A number of options exist for the future disposal of some or all of these buffalo and, if they were to be used for introductions to commercial farms as recommended by Morkel (1988), then the recipients would also become primary stakeholders. If they were used to establish a buffalo population at Mangetti Game Camp and if this area were to become a Conservancy of Chief Kahenge's people (PW 1998), then they too would need to be seen as primary stakeholders. If they were relocated to Etosha National Park, the Ministry would remain the sole primary stakeholder.

If they were sold in their entirety to South African buyers and the funds deposited in the Game Products Trust Fund as recommended by Fryer (2002), a number of secondary stakeholders might become the beneficiaries of the fund. Fryer recommends that some of the funds be used to construct a large paddock for the Tsumkwe buffalo herd – in which case the Nyae Nyae Conservancy would become a potential stakeholder.

The primary stakeholders for the Tsumkwe buffalo are the Nyae Nyae conservancy on whose land they are situated.[14] Because of its investment in capturing the buffalo and maintaining them at Tsumkwe, the Ministry of Environment must also be seen as a primary stakeholder. As in the case of the Waterberg buffalo, the identification of other stakeholders is dependent on the management decisions for the future of these buffalo.

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14. Fryer (2002) does not mention the Nyae Nyae conservancy in his recommendations to the Directorate of Scientific Services leaving the impression that this conservancy has little say over significant wildlife matters.

b. Stakeholder Institutions – Present and Future

Namibia has been in the forefront of the southern African region in developing policies and legislation which empower landholders to manage their wildlife resources both on commercial farms and, through the Nature Conservation Amendment Act of 1996, on communal lands. These enlightened policies have produced demonstrable results: the tourism industry in Namibia contributes some US$60 million annually to the national economy and, of this, some 14% is generated by international safari hunting on commercial and communal land (Humavindu 2001). The income to conservancies is expected to approach US$1 million in the year 2002 (Travel News Namibia 2002, p28).

An outsider cannot fail to be impressed by the plethora of organisations present in Namibia to support community based natural resource management and conservancy development, by the degree of cooperation and coordination amongst these agencies and by the excellent relationship between government and the non-government sector of supporting institutions. Also impressive is the high degree of technical skills which can be brought to bear on resource management issues.

In the highly optimistic climate surrounding the development of the wildlife and conservation industry in Namibia, criticism is therefore likely to be unpopular. Nevertheless, it is difficult not to harbour some small areas of disquiet over certain aspects of the developing institutions. It is stressed here that none of the comments which follow are intended to detract from the larger achievements which are well ahead of most other countries in the region. The comments are aimed rather at disturbing an apparent complacency that the framework for building institutions is finalised, satisfactory and in place – and all that is required now is to consolidate and develop within this framework.

In this subsection on institutions, three specific empowerment issues are examined –

(1) The present rights over wildlife conferred on commercial farmers;

(2) Policy and practice towards the empowerment of conservancies; and

(3) The rôle of State protected conservation areas in the Caprivi and their relationship to neighbouring communities.

(1) <u>The Rights of Commercial Farmers</u>

In 1994, in a passing conversation with a senior official from the Namibian wildlife department, I remarked on the fact that the State agency was still setting quotas and requiring permits for wildlife utilisation on alienated land. His response was “we have to do that to ensure that wildlife is not overexploited”. This misses the whole point of empowerment and incentives. The governing hypothesis is, that given full authority over wildlife resources, the incentive will be present for landholders to use them sustainably. The situation is no different to that dictating the relationship between a farmer and his[15] cattle: no-one questions that his motive is to husband his cattle in a manner which will provide a sustainable livelihood. In competitive land use situations

15. I am conscious of the gender implications here: however, using the full “his/her” elaboration makes for ponderous reading.

it is imperative that the rights of a would-be wildlife farmer are no different to those which he enjoys over his cattle if he is to make choices which value one resource above the other.

I have been told on numerous occasions that the present style of mixed cattle and wildlife farming on commercial farms in northern Namibia is likely to persist. Barnes and de Jager (1995) remark that there is little financial incentive for northern cattle/wildlife farmers to convert to 'pure' wildlife systems, either for consumptive or non-consumptive uses. I think there is an empowerment issue which has been overlooked here. At present Namibian farmers do not enjoy the same rights over their wildlife as they do over their cattle and this could be the single most important factor which is slowing down the process of farmers converting to 'pure' wildlife systems. In Zimbabwe, once farmers were granted this right it resulted in a 'domino effect' where one property after another switched to full wildlife systems without cattle and it led to the formation of large conservancies to manage wildlife over areas exceeding 3,000km^2 in extent.

A critical mass of lobbyists is unlikely to emerge from within the Namibian farming community to argue for the introduction of buffalo to northern farms until such rights are in place.

(1) The Empowerment of Conservancies

In Zimbabwe, whereas commercial farmers achieved full legal rights over their wildlife in 1975,[16] local communities under the much-touted CAMPFIRE programme (Martin 1986) have not yet been successful in obtaining similar rights. The wildlife department still sets quotas (illegally) for sport hunting and district councils remain the authority for wildlife in communal lands. The councils negotiate concessions with safari operators and frequently withhold all or part of the monies due to local communities.

Whilst the Namibian conservancy legal construct is very different to the provisions of CAMPFIRE, there remain disturbing similarities. Corbett and Jones (2000, Table 2) point to the disparities which exist between the intent of policy, the provisions of legislation and the actual implementation of conservancy programmes. Some of their points are given below –

- In policy, conservancies are intended to gain the same rights as freehold farmers and the legislation provides for this. In practice, the Ministry of Environment (MET) sets quotas for huntable game 'for own use' and requires conservancies to obtain permits.
- Although there is no legal provision for it, MET is requiring conservancies to submit management plans before quotas for trophy hunting and 'own use' are issued.
- In policy, conservancies should decide on tourism concessions: in practice MET has renewed expired concessions and issued new concessions in conservancies without consultation.

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16. Under Zimbabwe legislation, all wildlife has the Roman-Dutch legal status of *res nullius*, i.e. it can be owned by no-one. On alienated land the authority for wildlife is the landowner and in Parks Estate the authority is the Director of Wild Life – who consequently enjoys no powers over the management of wildlife on private land other than in respect of introduction of exotic species and the management of Specially Protected Species (e.g. black rhino).

- In policy, conservancies should be able to enter into joint ventures with the private sector as a bilateral agreement: in practice, there is a tendency by government to interpret policy as giving it a right to approve joint venture agreements.

From these examples, it is clear that full devolution of authority has not taken place. Murphree (2000) stresses that the purpose of devolution is to achieve the alignment of authority, responsibility and incentives – authority without responsibility is meaningless or obstructive, responsibility without authority cannot be effective and, without responsibility or authority, there are no incentives to invest, manage or control. Many planners and bureaucrats see devolution of power as a step-by-step process under which communities are granted powers incrementally as they demonstrate the ability to manage. This is 'Catch 22'. Authority is a pre-requisite for responsible management and should not be held out as a reward for it. Devolution carries with it the responsibility for organisation, management, control, self-sufficiency and, above all, for developing resourcefulness. These attributes cannot be imposed but must be developed experimentally in the local setting and, without authority, such experiments are defective. The stimulus arises not from the anticipation of future entitlement but from the imperative of immediate empowerment.

Corbett and Jones (2000, page 18) are critical of a tendency amongst government and NGOs to replicate their own bureaucratic systems and formalistic approaches to planning in conservancies. They point out the heavy burden of transaction costs which this imposes on communities. An outsider is left with the impression that there is still a high degree of 'nurse-maiding' attached to conservancies, an anxiety that communities should adopt the value-systems of the supporting agencies, a drive to "get things right first time" and a reluctance to allow communities to make mistakes – an essential element of the learning process.

The failure of the State and NGOs to treat land use as an experiment requiring considerable freedom of experimentation may lead to a "socially constructed stalemate" (Lee 1993, page 12).

> It is – *". . . a situation in which the State is unwilling to surrender its technicist and proscriptive policy approaches while lacking the resources to make them effective, while the local community lacks the authority and incentives to create effective policies and regimes responsive to local imperatives".*
>
> Murphree and Mazambani (2002: page 49)

(2) The rôle of State Protected Conservation Areas in the Caprivi

Corbett and Jones (2002, p19) raise the issue of possible land claims from local communities in respect of national parks created on land which was formerly communal land. They speculate on possible modes of restitution and include the option of partnerships in management and revenue-sharing arrangements. It is a sorry testament, to the discredit of government conservation bureaucracies throughout Africa, that there does not appear to be a single example where a full partnership for the running of a national park has been achieved.

The Caprivi is an interesting case study where the present land tenure categories do not lend themselves readily to optimum land use planning. Mendelsohn and Roberts (1997) show the different quality of habitats available to both people and wildlife and highlight the potential conflict areas in the Caprivi. The situation is not ameliorated by having a sharp dichotomy between land under State protection juxtaposed with subsistence agriculture and traditional cattle husbandry – even with the promising developments in conservancies.

A strong case based on the grounds of conservation and socio-economics could be made for re-examining the potential rôle these protected areas could play in the development of the Caprivi – provided they were not treated as an exclusionary domain in the national realm.

Martin (2002b) notes the continuous demand on governments for budget allocations to alleviate poverty and meet human needs in remote areas and remarks that it would be economically more efficient to avoid long circuitous flows of revenue from national parks in remote areas to central government which are then returned later in the form of grants or subsidies. The stronger local economies become the less of a financial burden these areas are to the State. Amongst the devolutionary options open to governments are those of treating national parks as regional, district or local assets – and, far from prejudicing the parks' primary ecological functions, it might even enhance them.

"A State without the means of some change is without the means of its conservation."

Edmund Burke (1729-1797). Reflections on the Revolution in France.

c. Towards Trans-Boundary Institutions

The complexity of the proposed 'Four-Corners Trans-Frontier Conservation Area' is daunting (Martin 2002a). To develop institutions involving not only the national governments of five countries (Angola, Botswana, Naimbia, Zambia and Zimbabwe) but also the other primary stakeholders is a formidable task made more complicated by the different legal systems and institutional approaches which have already evolved in each country. This complexity was recognised in the round-table discussions at the inception of this study and a pragmatic approach was agreed upon whereby the larger vision of a massive trans-frontier area, whilst being recognised as an ultimate goal, should be preceded by the building of a number of incremental initiatives aimed at collaboration between Namibia and its immediate neighbour, Botswana.

(3) The management of buffalo was seen as an appropriate vehicle for beginning in a small way to develop collaborative linkages. Obviously, if agreement can be reached on management measures which would be beneficial to buffalo, this would pave the way for consideration of a number of other shared species populations and broader ecological issues which transcend individual species.

(4) The conservation issues affecting the shared buffalo population have been outlined in the first two main sections of this report. A primary objective (for Namibia) is the avoidance of fragmented buffalo populations either through veterinary control measures or through the spread of unplanned settlement in the Caprivi. A secondary objective is the increase of buffalo numbers for both economic and conservation reasons.

(5) A key issue is the scale at which buffalo management needs to be addressed. At this stage, insufficient data exists to delineate any discrete buffalo subpopulation within the 'project

area'[17] and therefore, buffalo need to be considered over a large range extending from the Caprivi into northern Botswana.

(6) Such a large range extends well beyond the State protected area system in both countries and demands the involvement of local communities. Progress towards the empowerment of local communities to manage wildlife on their own lands in both Botswana and Namibia is well advanced but the development of strong local jurisdictions, whilst being a necessary condition for successful management, is not a sufficient condition to address ecological issues which transcend the scale of local community institutions (Murphree 2000).

(7) Murphree (2000) outlines the institutional developments which are required to achieve the matching of ecological and jurisdictional scales –

(i) Firstly, the entire institutional edifice needs to be constructed on a sound foundation of strongly empowered local community jurisdictions;

(1)Secondly, each community institution must delegate some of its powers to a higher level institution which embraces representatives from all of the separate institutions in the bottom tier (*Murphree's principle of "delegated aggregation"*);

(2)The higher level institution is directly accountable to the constituency which empowered it (*Murphree's principle of "constituent accountability"*);

(3)Thirdly, the resulting institutions should be no larger than needed to address a particular problem (*Murphree's principle of "jurisdictional parsimony"*).

(8) These principles can be applied to the problem in hand. The issue is not limited to local community institutions but should include the other primary stakeholders identified in the previous section. Governments and communities in both countries need to create the appropriate national level forums to take the issue forward to an international level.

(9) In **Fig.18** on page 56, I attempt to design such an institution. A key question is whether at the international level (i.e. between Botswana and Namibia) representation will be confined to government representatives or whether the 'cascaded institutions' (Martin 1999b) will permit other primary stakeholders to participate (i.e. local community representatives from the Caprivi and northern Botswana). In the diagram of Fig.18 I have followed the latter course but ultimately the decision on this issue lies between the two governments. The features of the organogram are as follows –

(1)Murphree's 'Principle of Jurisdictional Parsimony' has been applied insofar as the organisation consists only of primary stakeholders and only involves two levels. A third level (not shown in the diagram) is the individual membership of each conservancy in Namibia and each community area management organisation in Botswana.

(2)In Namibia, the individual conservancies in the Caprivi delegate limited powers upwards

17. Except, perhaps, the buffalo population along the Kavango River in the Caprivi.

to an ‘Association’ which will represent them at the second level (CAs). This could be the existing Communal Lands Board for the region or an association created especially for this purpose. The arguments in favour of using the Communal Lands Board are that the interests of communities who have not formed conservancies would also be represented.

(3)A similar association would need to be identified on the Botswana side of the border to represent the various areas under community wildlife management. This could be the relevant Land Board.

(4)The individual parks in the Caprivi and northern Botswana report to their Directorates which are represented on the second tier in each half of the structure.

(5)In Namibia, the Directorate of Scientific Services is also represented in the second tier. In Botswana, the equivalent agency is contained with the Department of Wildlife and National Parks representation.

(6)The veterinary authorities from both countries are also represented at the second level.

(7)These two groups at the second level from Botswana and Namibia meet to constitute the international ‘institution’ which addresses joint management issues.

It could be argued that many more parties should participate in the final bilateral forum including more senior government representatives. In line with both governments’ efforts to decentralise, it seems more logical that this forum be treated as a technical and advisory panel which reports back to the relevant ministries on matters which may require high level decisions. If the principles of delegation upwards and accountability downwards are adhered to, there is no reason why all of the representatives at the national level cannot report back their particular constituencies rather than overload the international forum with unnecessary numbers. Finally, if it is agreed between the two delegations, there is no reason why any observers who may contribute to the discussion are not invited to the forum.

Key to Acronyms used in the diagram – *see text for a fuller explanation of the structure*

Namibia:	CAs	– Conservancies Association
	DSS	– Directorate of Scientific Services
	DPW	– Directorate of Parks and Wildlife
	DVS	– Directorate of Veterinary Services
Botswana:	DWNP	-- Department of Wildlife and National Parks
	DAHP	– Department of Animal Health and Production
	CAs	– Community Areas Association

4. MANAGEMENT

In the terms of reference for this study it was intended that a section on "Present Conservation Measures" would be followed by a section on "Future Conservation Measures" but I have restructured the layout because of the nature of the findings which have emerged from the study.

a. Present and Future Buffalo Management in the Caprivi

The key factors which will determine buffalo numbers and distribution in the Caprivi fall largely outside the range of management activities undertaken within State Protected Areas and depend more on land use planning and veterinary control measures.

Mendelsohn and Roberts (1997, Chapter 9) give an excellent discussion of the conservation and land use planning issues in the Caprivi and make a strong case for biodiversity values to be taken into account in future planning. The impact of veterinary control measures on buffalo numbers and distribution has been analysed in Part 1.e.(1) of this report (pages 13-25) and should form the major topic for discussion in bilateral talks with Botswana on buffalo management.

(1) State Protected Conservation Areas, Conservancies and Financial Resources

The uncertainties surrounding the exact designation and final boundaries of State Protected Conservation Areas in the Caprivi (Mendelsohn and Roberts 1997, p7; PW 1998) does not enhance buffalo conservation and, clearly, a resolution of these issues will set the base line against which many other land use and conservation plans can be developed.

Buffalo benefit from the general management measures aimed at conserving wildlife in State Protected Areas and Conservancies and there are few, if any, management activities directed solely at buffalo conservation. Within State Protected Areas in the Caprivi a major effort is being made to contain illegal hunting, control fires and, in general, to implement Park plans. The present MET staff numbers, equipment and infrastructure in the Caprivi are insufficient to meet the challenges (PW 1998, page iii) but improvements are taking place in all these aspects. Martin (2002) examined the minimum requirements of game guards and budgets for effective functioning of State Protected Areas and the results are given in **Appendix 4** and shown in **Fig.18** below.

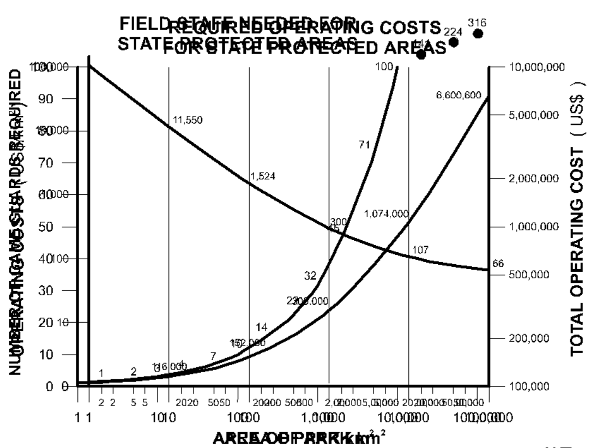


Table 9: Required Budgets for State Protected Conservation Areas in Caprivi

State Conservation Areas	Total Area km^2	Required Number of Guards	Required Annual Operating Budgets - US$	Cumulative Cost - US$
Popa Game Reserve	20	5	122,000	122,000
Mahango Game Park	200	15	177,000	299,000
Mamili National Park	280	17	193,000	492,000
Mudumu National Park	1,000	32	300,000	792,000
State Forest	1,500	39	359,000	1,151,000
Caprivi Game Park	5,500	75	727,000	1,878,000
All Protected Areas	*7,000*	*84*	*847,000*	

Based on the formulae of Appendix 4, notional budgets have been developed for the protected areas in Caprivi. It is of interest to note the effect of managing several small areas rather than a single large area. The costs of managing the first four parks on the list are approximately the same as those costs which would occur if the entire area from Mahango Game Park to the easterly boundary of the Forest Reserve were managed as a single unit.

These budgets set a critical threshold. Where the State provides an annual operating budget equal to or greater than required, there is a high probability that the area will be adequately managed and conserved. Where budgets are lower than the amounts needed, it is unlikely that a wildlife agency will be able to protect resources against any determined onslaught by illegal hunters. Automatically, the inspection of these thresholds should cause the senior staff of a wildlife agency to weigh the realities of typical present operating budgets against the magnitude of the expected tasks and, if funding is well below the required threshold, there is no merit in continuing dutifully with a model doomed to failure.

Progress with Conservancies in the Caprivi is impressive. Many of the apparently overwhelming conservation tasks expected of State wildlife agencies are likely to be reduced when protected areas are surrounded by functioning community land use systems based on wildlife and natural resources. The question a State wildlife agency needs to ask itself is whether the combination of stand-alone parks and game reserves (which may be seriously underfunded) and conservancies together provide an adequate land use planning framework to move forward with confidence into the future. In the section of this report on Stakeholders (page 52), the potential rôle of State Protected Areas in catalysing land use based on wildlife over a wider area was raised. Moves towards this will require continued innovation from enlightened Namibian bureaucrats and a re-definition of classic protected models.

(2) Illegal hunting

Levels of illegal hunting could affect the survival of buffalo. Tagg, Mayes and Scheepers (pers.comm. 10/10/02) state that significant illegal hunting is taking place. The population model developed in the first section of this report has been used to explore the maximum illegal harvest which a buffalo population of 3,000 could sustain. It is assumed that mortality would affect both sexes and all ages equally.

Illegal harvest %	0	1	2	3	4	5
Rate of population growth %	5.5	4.3	3.3	2.3	1.2	0.1
Years to reach 10,000 animals	24	29	37	54	154	563

Under the rainfall conditions in the Caprivi (which set female fecundity), the population can sustain slightly more than a 5% offtake. The higher the proportional offtake, the lower is the growth rate of the population and, at a 5% offtake, it is effectively stationary. To examine rates of population decline when the harvest exceeds 5%, it is not useful to examine percentage offtakes because these result in a lower and lower number of animals being killed as the population declines so that the population tends to stabilise at some low level.

A more realistic examination of rates of decline for unsustainable harvests has been done with a fixed number being removed from the population each year which inevitably results in extinction. In the table below, the number of years to extinction is shown for various fixed offtakes from a starting population of 3,000 animals.

Illegal harvest (% of 3,000 buffalo)	6	7	8	9	10	15	20
Fixed annual offtake	180	210	240	270	300	450	600
Years to extinction	46	28	21	17	14	8	6

This is relevant to any legal hunting of buffalo for ‘own use’ by registered conservancies in the Caprivi. The maximum sustained yield from a population capable of growing at 5% per annum is about 5% and quotas should not exceed this. Far more important is that this type of use is financially and economically short-sighted. The returns possible from international sport hunting of buffalo are so much higher than subsistence uses that there is no sense in pursuing short-term lower valued options. Moreover, there are no short-cuts in the process: there is no sex or age class of the buffalo population which can be hunted for meat without prejudicing the overall potential in the international safari hunting market.

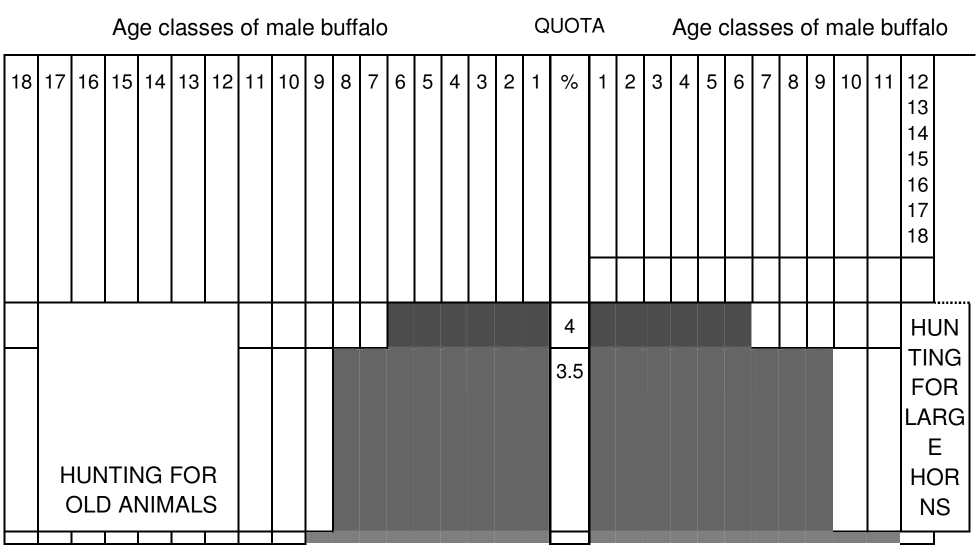
(2) Sport Hunting of Buffalo

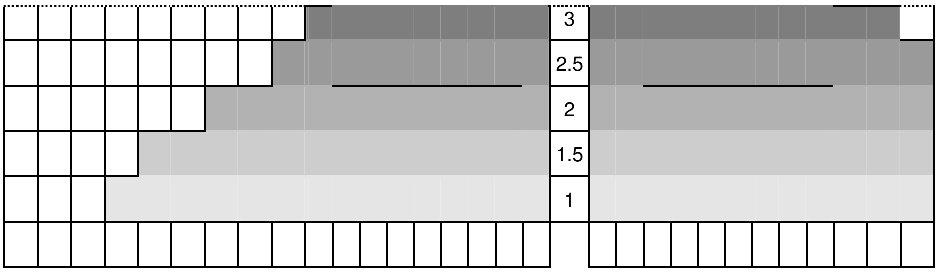
The present trophy quota for buffalo (less than 10 in the entire Caprivi) is unlikely to have any impact on the buffalo population. If the population as a whole is about 3,000 animals it could tolerate a quota of some 90 trophy bulls. If, as assumed in the hunting model (Section 2), there is a 'huntable population' of about 1,000 animals outside protected areas, a quota of 30 animals would be sustainable.

I have used the population model shown on page 10 to explore the effects of hunting quotas on a buffalo population. Two very different modes of buffalo trophy hunting exist in the safari hunting industry. In the first one, the emphasis is on securing old animals with big horn bosses as trophies (hunting clients from western Europe): in the other, the aim is to get a trophy with a very large horn measurement which may enter the hunting record books (United States clients). Under the first mode of hunting, the older age classes in the population come under the greatest pressure: under the other, it is males in their 'prime' (8-12 years old) that come under pressure. Critics of this last mode of hunting say that it affects the breeding performance of buffalo because the largest males are being removed from the breeding herds whereas, in the other mode, it is usually solitary animals past their breeding prime which are being hunted. These same critics argue that if it is only bulls which have left the breeding herds which are hunted, hunting quotas could also be higher (Grellmann pers.comm. 14/10/02).

Both modes of hunting have been tested (**Table 10**). In the first mode (hunting for old animals), the assumption is that the oldest males in the population are taken first and, as the hunting quota is increased, younger and younger age classes are progressively affected. In the second mode (hunting for big horns), selectivity is centred on the 10 year old males, with 50% of trophies coming from animals 9-11 years old and 80% of trophies coming animals 8-13 years old.

Table 10: Effects of hunting quotas and hunting modes on the age structure of male buffalo





Irrespective of the method of hunting, when the quota approaches 4% (of the total population) there will be no males in the population older than 6 years of age. At this level it could be reasonably assumed that breeding would be drastically affected. At a 3½ % quota, a few males survive to 9 years old under the ‘big horn’ hunting regime, but there are no males older than 8 years if hunting is focussed on ‘old animals’. At a 3% quota, there are males surviving to 11 years old under ‘big horn’ hunting, but none older than 9 years when hunting for ‘old animals’. When the quota is 2½ %, under either hunting regime there will be some males older than 10 years and this is probably an optimum hunting level – producing the highest sustainable number of trophies yet leaving sufficient prime males for breeding purposes.

If the entire emphasis is on hunting for old animals, the older age classes are ‘cleaned out’ very quickly – a quota of 1% results in all animals older than 16 years being removed from the population. Although apparently attractive as a hunting strategy and appealing to the ethical sense of many hunters, the regime of hunting for old animals is not able to provide the same number of trophies as the ‘big horn’ regime very simply because old age mortality is also operating on this part of the population and claiming a significant portion of each age class.

I conclude this section on sport hunting by discussing the methodology for setting quotas and monitoring sustainability. It is not necessary to know the numbers of buffalo in the population in order to set sustainable quotas – indeed a system based on population estimates is likely to be far less robust than an adaptive management system (Holling 1978, Bell 1986, Martin 1999b) because, firstly, the confidence intervals on buffalo estimates are very large and, secondly, the area of interest is not the total number of animals in the population but the number of adult males older than (say) 8 years – which is only about 5% of the population. The lack of precision on buffalo estimates tends to be magnified when applied to this small cohort in the population.

The key parameter to be monitored is the age (or size) of trophies taken from the population. If a criterion is set that there should always be a sufficient number of prime breeding males, then the requirement is that amongst the trophies (regardless of the type of hunting regime analysed above), there should be a representative number of males in the age classes above 10 years old. As soon as the cohort of hunted animals is missing all of the age classes older than about 10 years of age, this is a robust indicator that the population is being overhunted and the quota should be reduced. An initial quota might be set by the crude method of applying 2½ % to the population estimate but thereafter that quota should be adjusted upwards or downwards by the ‘hard data’ (as opposed to the ‘soft data’ of population estimates) which comes from measuring trophies. Taylor (1995, pages 266-298) gives a precise method of ageing buffalo from their dentition – which could easily be applied by local community monitoring staff with some training. It is logical that conservancies should take on this monitoring rôle in all areas where buffalo are hunted in conservancies since it is effectively their resource being managed. In State protected areas where there is hunting this would be the responsibility of the parks staff.

The principle can be applied to the hunting of other species where trophy quality is an important factor. Adaptive management is a better methodology than the blind application of percentage offtakes to populations since it tests the underlying hypotheses about population age structures and the sustainability of hunting quotas.

(3) Monitoring

In general, most monitoring activities should be applied within an adaptive management framework. Bell (pers.comm. 2000) said "*In the early stages many of us saw adaptive management as a research process to reduce uncertainties. These days it should be stated as part of the definition of adaptive management that intensive levels of research or monitoring which will result in a system being too expensive, and hence unsustainable, cannot and should not be attempted.*" One example has been given of the use of adaptive management to set hunting quotas where there is a focussed objective and monitoring is aimed at realising that objective. A second situation arises, specifically within the Transboundary Species Project, with the need to assess whether the objective of increasing buffalo populations is being achieved.

The difficulties of counting buffalo were outlined on page 26. Present air survey techniques are not suited to precise or accurate estimates of buffalo populations and would be unable to detect an increase of 500 animals in a population which was nominally 3,000 animals (which is the situation this project would be in if it wished to detect the increase in Caprivi buffalo growing at 5% per annum after 3 years). Gibson (pers.comm.)[18] has proposed a method by which better estimates might be obtained for buffalo. On any survey buffalo will be encountered both in large herds and in small groups (usually 'bachelor' herds) and the standard air survey method is adequate to capture the smaller groups. To estimate the numbers in large groups a second aeroplane should fly above and behind the first at height such that it is surveying a strip width of about 1km either side of the transect line.[19] The observers in the second aircraft are solely concerned with detecting large buffalo herds which, when encountered, are photographed and counted from the photograph after the survey. By the application of the same statistical methods, the large herds can be incorporated accurately within the census.

Such a survey would be expensive but it need not be repeated very often. In the example given above, one survey could be carried out at the inception of the project and another 3 years later. Thereafter, possibly through the development of community monitoring techniques, a cheaper alternative for detecting the trend in buffalo numbers may be found. There are no guarantees for air surveys that, even if they are carried out at exactly the same time of year, other variables (e.g. rainfall) may not affect the numbers of buffalo actually present in the Caprivi at the time.

18. D.St.C. Gibson and G.C. Craig have carried out numerous air surveys in the southern african region including several in the Caprivi.
19. If the strip width at 300 ft above the ground is 150 metres then, with the same streamer settings, the height needed for the second aircraft to survey a strip width of 1km each side of the aircraft is 1,700 feet.

The development of conservancy monitoring systems by the NACSO[20] unit in the WWF LIFE programme offices is impressive. It is critical that conservancies are able to perform self-diagnosis and self-correction in their management – a process for which their system seems well-suited. The system is capable of being expanded depending on the priorities which emerge for monitoring.

It is also pre-emptive in the sense that the conservancies will be able to produce their own progress reports for outside consumption without having standard donor project monitoring and evaluation (M&E) imposed on them. Project beneficiaries are usually not trusted to be able to evaluate the impact of their own activities and the 'classical' M&E is an episodic event conducted by outsiders. The prescribed corrections from the dreaded M&E report usually result in a rearrangement of project activities and the limping vessel lurches onto a new course. This hardly resembles the experimental approach epitomised by adaptive management, where uncertainty is seen as the norm, where mistakes are seen as part of the learning experience (Bond, 1997) and the project implementers are able to make the needed corrections to the ship's course on a regular basis as a result of their own diagnoses.

(4) Elephants

In the discussion of factors possibly limiting the buffalo population in Caprivi (page 36), the large elephant population (5,000-10,000 animals) was put forward as perhaps being responsible for a reduced food supply for buffalo. In areas where annual rainfall is 500-600 mm, elephant densities greater than $1/km^2$ result in marked changes to woody vegetation and it can be presumed that the grazing sward is also affected. There have been no population reductions of elephant in either northern Botswana or Caprivi as part of ecosystem management in recent times (if ever) and this management option could be considered. It is a topic which should be discussed jointly with the Botswana authorities.

(3) Artificial water

Buffalo are very much dependent on existing water supplies in the Caprivi and, for a large part of every year, this means they are tied to the large rivers. This limits the ability of the populations in the eastern and western ends of the Caprivi Game Reserve to maintain contact and, in conjunction with the veterinary fences along the Botswana border and a hostile environment in Angola, could result in the total isolation of the Mahango subpopulation.

The development of game water supplies in the large Kalahari Sands area of the Western Caprivi Game Reserve would not only address this problem but would also allow the persistence of buffalo populations in areas away from the main rivers on a perennial basis. The difficulties of doing this are not underestimated: Mendelsohn and Roberts (1997, page 39) show the average depth of water below the surface in western Caprivi as varying from as much as 300 metres in the west of the Caprivi Strip to 35 metres in the east. A number of boreholes have been sunk in the area but most are non-functional and would not provide the water needed for large buffalo herds.

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20. Namibian Association of CBNRM Support Organisations

(4) Fire

Mendelsohn and Roberts (1997, pages 24-25) present a compelling picture of the gravity of the fire situation in Caprivi with burns commencing as early as April each year and continuing until December when over 60% of the vegetation has been burnt and the total count of individual fires may have exceeded 3,000. It seems that at one time there was an extensive network of firebreaks in Caprivi to control fires and it would obviously be beneficial if these could be resuscitated.

b. Captive bred buffalo

The origins of the Tsumkwe herd of buffalo were mentioned on page 18, the numbers of buffalo in Waterberg herd and the Tsumkwe herd were noted on page 34 and the stakeholder issues relating to these buffalo were discussed on page 49. In the Waterberg Plateau Park the numbers of buffalo are approaching carrying capacity and, in the present buffalo paddock at Tsumkwe, carrying capacity has been exceeded. In this section, the options for managing these buffalo are evaluated.

Being disease-free, the animals are extremely valuable – current prices in the regional live sales market for buffalo are around N$200,000 each. It is financially irresponsible not to manage these particular herds under a regime where they are breeding at the maximum rate – which will only be achieved if their numbers are kept well below carrying capacity.

The first question to be addressed is whether the Waterberg animals, which originated mainly from Addo National Park in South Africa, should be treated separately from the Tsumkwe herd. The danger in allowing these animals to breed with other buffalo of Namibian origin is that of 'outbreeding depression'. If the Waterberg buffalo contain genetic characteristics which differ from Namibian buffalo, the resulting hybrid of the two could demonstrate a reduced fitness – which might be shown by impaired breeding performance. There are some strong arguments against allowing this potential danger to influence management decisions –

(1) Both the Namibian and the Addo genotype are the same subspecies;

(2) No external features of the introduced buffalo lead to the conclusion that phenotype is morphologically different;

(3) The genetic characters which lead to outbreeding depression are seldom integrated into the gene complex of an organism as a whole: usually they are restricted to a few gene sites on a particular chromosome 'arm' (Templeton 1985);

(4) The Waterberg stock have been present in Namibia for over 20 years and will already have undergone genetic modification in response to their particular environment;

(5) The risk of inbreeding depression may be higher than that of outbreeding depression;

(6) Outbreeding depression, if it were to occur, is usually a temporary phenomenon which is rectified by natural selection within a few generations (Templeton, 1985);

(7) Very often the resultant product of hybridisation, or their offspring, may possess superior

characteristics to the original founder stock (Templeton, 1985).

Templeton questions the philosophical approach of those who seek to preserve the unique physical characters represented by a particular 'species' (in the subject under discussion it seems that there are not even any of these which can be identified – rather there is a vague foreboding that there may be some hidden characteristics in the Addo buffalo) because this static approach tends to deny the dynamic nature of evolution.

In an articulate discourse, Templeton (1985) asks whether we should be saving 'species' as defined by a currently existing constellation of traits, or 'species' which represent a unique evolutionary lineage. The species definition one accepts has a profound impact on management decisions in a case such as this. Under the static approach, it is assumed automatically that the existing population (i.e. the Namibian buffalo) must be preserved as is, and any genetic changes which might arise through crossing with Addo buffalo must necessarily be "bad'. Under the evolutionary lineage concept, allowing a new superior gene complex to evolve is not at all "bad".

"The conservation biologist should not try to suppress evolutionary change in all circumstances – rather the conservation biologist should use evolutionary change as a beneficial and powerful management tool for preservation of endangered evolving lineages — species."

For me, the ultimate irony is that buffalo went extinct long ago in north-central Namibia and whatever buffalo are used to repopulate the area, they will not be identical to the ones which disappeared. **My recommendation is that the Waterberg buffalo be treated no differently from the Tsumkwe buffalo**.

The Namibian scientific and management authorities have a conservation and economic opportunity presented by some 300 buffalo in total located in two sites not very far apart where both groups are beginning to exceed carrying capacity. The buffalo are extremely valuable because they are disease-free. In the course of discussions whilst in Windhoek in October, the following options for the management of these buffalo were put forward –

(a) Introductions to commercial farms (recommended by Morkel 1988);

(b) Establish a buffalo population at Mangetti Game Camp (and use this as an opportunity initiate a Conservancy of Chief Kahenge's people);

(c) Re-establish buffalo in Etosha National Park;

(d) Sell buffalo to South African buyers.

All of these would seem desirable aims and none of them are mutually exclusive. My feeling is that these are decisions to be made by the Namibian authorities (including the veterinary authorities) in consultation with the various stakeholders identified in Section 3. I restrict my recommendations to principles which might be followed in managing the two populations.

(5) If it is decided to treat the Waterberg and Tsumkwe populations identically, at an early stage some mixing of these animals should take place to minimise inbreeding and increase the genetic diversity. This could be done in several ways but the following two options appear the most logical –

(1) Some Tsumkwe animals[21] could be introduced to the Waterberg where the population is not yet at carrying capacity. The reverse does not seem sensible because the Tsumkwe population is overstocked in the small paddock where they are presently held). This would also maintain maintain the genetic identity of the Tsumkwe buffalo.

(2) A new population could be started in a third locality with animals from both the Waterberg and Tsumkwe populations. This could be treated as research experiment to test for outbreeding depression: if reproductive performance or offspring viability differed from that in either of the founder populations, it would answer a question.

(6) The range available to the Tsumkwe buffalo needs to be substantially increased. Fryer (2002) recommends the construction of a 10,000ha paddock: however, at a stocking rate of 0.5 buffalo/km^2 (see page 34) this would only provide grazing for 50 animals and, in the next paragraph, it is further recommended that the populations are managed at half of carrying capacity. If the Tsumkwe population will soon number 100 animals, this implies an available range of 250 km^2.

(7) To maximise population growth it is recommended that both populations are kept well below carrying capacity. At half of carrying capacity, the Waterberg herd should be managed for a maximum of 200 animals (carrying capacity for an annual rainfall of about 500mm would be about 1/km^2) and, if the Tsumkwe range is increased to 100 km^2, the population should not exceed about 25 buffalo.

21. It might be prudent to limit the introduction to a group of females because males run a risk of being killed.

(8) Within the finite range available to both populations, calf production could be increased by skewing the population structure in favour of females. With a given amount of grazing, it is better to put all of it into supporting females and sell redundant males.[22]

(9) In making sales or establishing new buffalo populations, the number of founder animals should be as large as possible to give the maximum chance of success. Founder groups should consist of at least 1 adult male and 5 females and preferably be much larger (this statement flies in the face of the previous recommendation but it is possible to treat the two issues separately !).

(10) At all times, the financial value of the animals should guide decision taking. Conservationists are inclined to take decisions in what they perceive are the best interests of animals and frequently these carry unrealistic financial implications, or worse still, a logical investment is rejected because it appears too expensive. For example, the costs of fencing a new 10,000ha paddock for the Tsumkwe buffalo might be N$500,000 (40km @ N$12.5/metre): this can be paid for by the sale of 3 buffalo.

(11) The value of the animals provides a unique opportunity to strengthen conservancies. Nyae Nyae conservancy should recognised as the 'co-owners' of the Tsumkwe herd, be fully consulted on its management and should benefit to the maximum extent from all sales. This situation does not arise in the case of the Waterberg buffalo but the wildlife department might choose to use some of the animals to begin new populations which will ultimately benefit conservancies. The proposals to use buffalo as the 'seed investment' to initiate a conservancy at Mangetti seem far-sighted.

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22. The FMD-free buffalo population in Zimbabwe was managed in this manner for some 10 years and spectacular growth rates were achieved (over 20% per annum). Also, farmers were so anxious to obtain buffalo that they were prepared to purchase males against the expectation that at a later stage this would be followed by females. The males were also valuable simply as sport hunting trophies.

c. Transboundary Issues

A number of areas have been identified in this report where collaboration between Botswana and Namibia could enhance buffalo populations. These are presented below in the form of a possible agenda for the workshop which is to be held in Kasane on 30th November 2002.

Botswana's buffalo population is of the order of 100,000 animals and is one of the largest in Africa – exceeded only Tanzania's population of about 300,000 buffalo. Namibia stands to be the greater beneficiary from co-operation with Botswana on management issues than *vice-versa*. Namibia's primary conservation objective is to avoid fragmentation of its present buffalo population and certain spatial linkages with Botswana are the key to achieving this. A second conservation and economic objective is to increase buffalo numbers in the Caprivi and here, too, the large reservoir of buffalo in northern Botswana could accelerate this process.

The question of the scale at which buffalo populations should be managed is an important one. In this course of this study it has not been possible to identify of discrete subpopulations of buffalo and, therefore, the scale under consideration at the outset of this collaborative process must embrace the full northern Botswana buffalo population and all of the animals in the Caprivi. Later it may be possible to refine management to specific subpopulations. This gives a very strong incentive for collaboration – the buffalo range transcends that of individual State protected areas and community based conservation areas and, therefore, to manage it at the right scale requires institutions which are capable of seeing the problem over a very large area (some 170,000km^2).

(12) Veterinary Control Measures

The combination of veterinary control measures and unplanned settlement perhaps pose the greatest threat to buffalo in the project area. The trend in Namibia towards isolated subpopulations in Caprivi is of concern. Scott-Wilson (2000) put forward four options to mitigate the effects of veterinary fences in northern Botswana and the consultant was informed in October (Jan Broehhuis, pers. comm.) that no decision had yet been taken on these options and, indeed, a new alternative solution might be pursued.

(13) Illegal Hunting

Levels of illegal hunting in Caprivi are higher than in northern Bostwana and, ultimately, if these cannot be contained could have a deleterious effect not only on Namibia's resident buffalo population but also on the larger population of Bostwana. There may be collaborative measures that could assist in reducing illegal hunting of buffalo.

(14) Elephants

The possible impact on buffalo of the very large elephant population in the project area (more than 100,000 animals) has been discussed in this report. Elephant management is a high-level issue on which technical collaboration is essential.

(15) Fire

The Caprivi suffers from an excessive burning regime every year. Whilst few of these fires originate from Botswana, this may be an area where co-operative effort would result in a reduction in the number and extent of fires.

(16) Buffalo Population Estimates

The inadequacy of present air survey techniques for counting buffalo is highlighted in the report and is reflected in the variability and high confidence limits of both the Botswana and Namibian population estimates. Recommendations are put forward in the report for developing an improved survey method suited to the manner in which buffalo are dispersed.

(17) Liaison on Hunting Quotas

The impact on buffalo hunting quotas both for sport and for community use has been addressed in some detail in this study. It is possible that both Namibia and Botswana could affect each other's safari hunting industry through the use of excessive hunting quotas. This is an area of liaison which would require little effort and could produce significant economic gains. In the areas on either side of the international border where hunting is taking place from what may be the same herds, there is good case for developing local institutions at the appropriate scale which would enable the proceeds from an overall quota to be shared proportionally amongst the participating conservancies and community areas.

Conservation Assessment Management Plan
Taxon Data Sheet

This sheet has been completed for the Southern Savanna Buffalo *Syncerus caffer caffer* only and does not include the other three subspecies of *Syncerus caffer* listed by the Antelope Specialist Group of the IUCN Species Survival Commission (ASG 1998). Where the term 'Project Area' is used it refers to that area which includes the buffalo populations of south-eastern Angola, northern Botswana, the Caprivi Strip in Namibia, the south-western corner of Zambia and the north-western corner of Zimbabwe.

PART ONE

1. **Scientific Name**: *Syncerus caffer caffer* (Sparrman 1779)
   - 1A. Synonyms: None
   - 1B. Scientific nomenclature
     - $1B_1$. Family: *Bovidae* Subfamily: *Bovinae* Tribe: *Bovini*
     - $1B_2$. Order: Artiodactyla
     - $1B_3$. Class: Mammalia
   - 1C. Common names: Southern savanna buffalo (ASG 1998), Cape buffalo
   - 1D. Taxonomic level of assessment: Subspecies
   - 1E. Country: Distributed throughout southern and central Africa as far north as Zaire, Uganda, southern Ethiopia and north-eastern Kenya (see Fig.2, Main Report)

2. **Distribution of the taxon**
   - 2A. Habit or life form: – (plants only) *not applicable*
   - 2B. Habitat of the taxon (ecosystem level): Savanna grasslands and woodlands
   - 2C. Habitat specificity (niche, elevation, etc.)

     The species is widely distributed and occurs in most savanna habitats from sea level to montane woodlands. It is a bulk grazer requiring adequate grass, water and shade (Smithers 1983).
   - 2D. Historical Distribution (Global – in past hundred years described by country)

     Prior to 1900 the species enjoyed a wide distribution throughout southern Africa being limited only by rainfall (see Fig.7, Main Report). It was severely reduced by a rinderpest epidemic at the end of the 19th Century but recovered well and had recolonised most of its former range by the middle of the 20th Century. The advent of veterinary control fences in the 1960s aimed at controlling the spread of Foot and Mouth disease in cattle resulted in the species being eradicated from many parts of its former range in southern Africa (see Fig.11, Main Report).
   - 2E. Current distribution (listed by country)

     A detailed description of the present distribution within each range country is given in ASG (1998) and the range in southern Africa is shown in Figs. 12, 13, 14 and 17 of the Main Report.
   - 2F. Current geographic extent of taxon's distribution being assessed in this workshop

     The shared buffalo population of Angola, Botswana, Namibia, Zambia and Zimbabwe is the main focus of this workshop. The national buffalo population of Namibia which includes some additional subpopulations not shared with neighbouring countries is also under consideration.
   - 2G. Concentrated migration sites (using political units)

     There is considerable movement of buffalo amongst the countries listed above with the greatest migrations occurring between Botswana and Namibia. Areas of buffalo concentration are on the Kwando and Chobe/Linyanti Rivers systems.

3. Approximate **EXTENT OF OCCURRENCE** of the taxon in and around the area of study

(Extent of occurrence is defined as the area contained within the shortest continuous imaginary boundary encompassing all known, inferred or projected sites of current occurrence of the taxon)

☑ > 20,000 km^2 (The range in Botswana alone is almost 200,000 km^2)

4. Approximate **AREA OF OCCUPANCY** of the taxon in and around the area of study
(Area of occupancy is defined as the area occupied by the taxon within the 'extent of occurrence')

☑ > 2,000 km^2 (The core areas in Namibia alone are about 10,000 km^2)

5. Number of **Populations** and **Subpopulations** in which the taxon ids distributed

In Namibia there are two isolated subpopulations of Foot and Mouth disease-free buffalo: one in Tsumkwe (68 animals) and one in the Waterberg Plateau Park (over 200 animals). At this stage, the main buffalo population shared between Botswana and Namibia can be regarded as a single population. However, there is a strong possibility that the Namibian Caprivi Strip population could become fragmented into about 4 subpopulations if more land is cleared for subsistence agriculture in certain key areas (see Main Report page 31 for a fuller discussion). In Botswana, four sub-populations of the main population have been defined for management purposes (ULG 1995).

6. Habitat Status

Are the subpopulations contiguous or fragmented or is the situation not known ?

See Point 5 above.

6A. Is there any change in the habitat where the taxon occurs ? ☑ Yes

A decrease in range available to buffalo is occurring in the Caprivi Strip due the spread of human settlement, subsistence agriculture and competition with cattle for grazing. The shared range with northern Botswana is also being curtailed through veterinary control fences.

6B. If Decreasing, what has been the decrease in habitat (approximately) over 10 years ?

☑ < 20%

The loss of habitat has been calculated as follows --

a. *It is assumed that loss of habitat is exactly equal to the amount of new land cleared for agriculture every year and that this amount of land is directly related to the rate of increase in the human population.*
b. *The total area of land in the Caprivi Strip is 20,000 km^2. The area of land cleared for agriculture in 1996 was 2,077 km^2 and the rate of increase of the human population has been 4% per annum for the past 20-30 years (Mendelsphn and Roberts 1997).*
c. *Based on the assumptions above, the amount of land cleared for agriculture in 2002 is 2,627km^2. Ten years ago it would have been 1,775 km^2. Thus 852 km^2 of buffalo range in the Caprivi has been lost over the past 10years. The range available to buffalo 10 years ago was 20,000 - 1,775 = 18,225 km^2. The percentage loss in the range available to buffalo over 10 years is therefore 100 x 852/18,225 = 4.7% or 0.5% per annum.*

6C. If Stable or Unknown, do you predict a decline in habitat in the future ? – *not applicable*

6D. State the primary cause of change: Expansion of human populations

6E. Is there any change in the quality of habitat where the taxon occurs ? ☑ Yes

☑ Decrease in quality

6F. State primary cause of change

Several factors are reducing the quality of habitat: excessive fires, cattle grazing and a very large population of elephant.

7. Threats

7A. What are the present threats to the taxon ?

Only the relevant threats listed in each major category on the CAMP form are presented below and they are given in order of priority

Human interference	Loss of habitat *(through human population expansion)* Habitat fragmentation *(same cause)* Hunting *(illegal - for food)*
Natural/Man induced threats	Interspecific competition - livestock Interspecific competition *(elephant)* Disease *infection from cattle of various diseases including – Rinderpest, Bovine tuberculosis, Contagious Bovine Pleuro-pneumonia (CBPP), Anthrax, Brucellosis*
Catastrophes	Drought Fire *(effects on habitat)*

7B. Might these threats result in a population decline?

☑ Yes If yes, indicate which threats are resulting or may result in population decline –

Habitat loss and fragmentation, Illegal hunting, Interspecific competition *(cattle and elephant)*, Disease *(rinderpest)*, Drought and Fire.

8. Trade

8A. Is the taxon in trade ? ☑ Yes Local, Domestic, Commercial and International

8B. ☑ Meat *This is a local and commercial trade from illegally hunted animals*

☐

✓ Live animals *Buffalo, particularly Foot and Mouth disease-free animals, are highly sought after for restocking wildlife areas. The trade is commercial and international.*

☑ Horns *There is a limited legal commercial curio trade in buffalo horns and hooves*

☑ Hides *Buffalo hides are used in the leather tanning industry*

☑ Trophies *Buffalo are a key species in the international sport hunting industry and this could be viewed as commercial trade.*

CITES passed a resolution at the First Meeting of the Parties in Costa Rica in 1987 that sport hunting trophies would not be treated as items in international trade. However, the Parties have made numerous exceptions to this (e.g. elephant, leopards, cheetah).

8C. Which form of trade (specified form) is resulting in a perceived or inferred population decline ?

None.

It is possible that illegal hunting could be exceeding the maximum sustained yield of the population but this is not established. All the other forms of trade are highly beneficial to the species. The manner in which this question is phrased is prejudicial – it is automatically inferred that trade is likely to be detrimental – despite the fact that CITES adopted a resolution in 1989 in Kyoto recognising that trade could be beneficial to species.

9. Population numbers

9A. Global population: > 548,000 (Southern Savanna Buffalo, ASG 1998)

9B. Populations and Subpopulations *(Botswana, Namibia, North West Zimbabwe)*

Population	Number	Subpopulation	%
Northern Botswana	90,000	Okavango Delta	97.1%
		Chobe/Linyanti	2.0%
		Kwando River	0.6%
		Zimbabwe border	0.3%
Namibia	3,000	Caprivi Strip	90.0%
		Waterberg	7.0%
		Tsumkwe	3.0%
North-west Zimbabwe	15,000	Hwange NP	57%
		Matetsi Safari Area	43%

9C. Number of **Mature Individuals** (in all populations) ☑ > 2,500

From the population model presented in Table 2 of the main report, the number of mature individuals (for buffalo this can be taken as all animals over 5 years of age) is about 60% of the total population.

9D. Average age of parents in population: 9.2 years *(also calculated from population model)*

10. Population numbers

10A. Is the population size/numbers of the taxon: *(In this Project Area)*

☐ Declining ☐ Increasing ☐ Stable ☑ Unknown

The confidence intervals on the estimates of the populations in Botswana, Namibia and Zimbabwe do not permit an assessment of trends. ASG (1998) assess the trend in the total population of southern savanna buffalo as stable or decreasing.

10B. If Declining, what has been the rate of population decline perceived or inferred ?

Not applicable

10C. If Stable or Unknown, do you predict a future decline in the population ?

If present trends in habitat loss, extension of veterinary fences and increase in the elephant population continue is likely that the population in the project area will decline. On the other hand, if community conservancy projects succeed and optimum land use can be achieved the buffalo population will increase.

11. Data Quality

11A. The above estimates are based on: ☑ Census ☑ Literature

12. Recent field studies

Apart from the annual aerial surveys carried out in the project area which are detailed in Tables 4, 5 and 6 of the main report, there do not appear to be any publications specific to buffalo. Research on radio-collared buffalo has been carried out in northern Botswana by M. Vanderwalle and in north-western Zimbabwe by C. Hunter in the past 5 years. However, no publications or reports resulting from these studies were seen at the time of completing this taxon data sheet.

There is an extensive body of literature on the global population of the southern savanna buffalo and many of the key population studies are given in the bibliography of the main report.

PART TWO

13. Conservation Status

Current Status

13A. Current IUCN Red List Category (1996 Red List): Lower Risk (conservation dependent)

13B. CITES: Not listed on Appendix I or II of the Convention

13C. National Wildlife Legislation: No special provisions

13D. National Red Data Book: Not a threatened species in Botswana, Namibia or Zimbabwe

13E. International Red Data Book: Not listed in the higher risk categories

13F. Other legislation: Not aware of any relevant legislation

13G. Known presence in protected areas

Present in all the protected areas within northern Botswana, the Caprivi Strip in Namibia and in north-western Zimbabwe. Thought to survive in the protected areas of south-eastern Angola (Bikuar NP, Mupa NP and the complex of Strict Nature Reserves centred on Luina in the extreme south-east corner) and in south-western Zambia (Sioma-Ngwezi NP, Liuwa Plain NP and West Zambezi GMA).

13H. National or regionally endorsed protection plan: A species management plan is in preparation.

Assigned Status

13I. Assigned IUCN Red List Category: Lower Risk (conservation dependent) ASG(1998)

13J. IUCN Criteria based on: Population estimates (*assumed*)

PART THREE

14. Supporting Research recommended for the taxon: ☑ Yes

☐

✓ Survey Aerial surveys should continue but there is a need for improved methods to census buffalo

☐

✓ Genetic research The genetic status of the animals in the Waterberg subpopulation requires clarification

☐

✓ Subpopulations The extent of buffalo movements between the 'core areas' in the Caprivi Strip would be useful information for management

14A. Is Population and Habitat Viability Assessment recommended: ☑ No

15. Management Recommendations for the taxon *in the project area*

☑ Habitat management Control of fire is needed

☑ Sustainable Use Illegal hunting requires to be minimised and legal uses promoted

☑ Limiting factor management Water supplies need to be developed in certain key localities

☐

✓ Monitoring Adaptive management systems are needed for sport hunting with trophy quality and hunting effort being the key parameters for monitoring. Monitoring of population numbers should be ongoing.

☐

✓ Captive breeding The production of disease-free buffalo for restocking areas in Namibia and elsewhere in the region is a valuable use of buffalo.

☐

✓ Translocation The establishment of new buffalo populations in areas of Namibia which were once part of the buffalo range is a desirable objective.

☑ Work in local communities — This is probably the most important requirement

16. Captive Breeding is recommended for:

☐

✓ Reintroduction — Subject to veterinary constraints, buffalo could be re-established in large areas of Namibia

☐

✓ Commercial trade — Sale of disease-free buffalo could raise the funds and provide the incentives needed for conservation of buffalo populations

17. Do **Captive stocks** already exist ? ☑ Yes

17A. Names of facilities: (1) Waterberg Park (2) Tsumkwe - Nyae Nyae Conservancy

17B. Number in captivity: (1) 200+ (2) 68

17C. Does a coordinated **Species Management Programme** exist for this species: In preparation
Country and Institutions: Namibia, Ministry of Environment and Tourism

17D. Is a coordinated **Species Management Programme** recommended for the range country ?
Presumably such a recommendation would emerge out of a CAMP workshop. In this instance the question is not relevant.

18. Level of captive breeding recommended

None of the options offered. The level should be determined by (a) the existence of suitable areas; (b) the costs of the operation; (c) the demand for the product; and (d) the income realisable.

19. Are techniques established to propagate the taxon ? ☑ Yes

20. Other comments see attached final page

PART FOUR

21. Sources of data used to complete this form: see Bibliography in Main Report

22. Compiler: R.B. Martin Consultant – Transboundary Species Project of the Namibia Ministry of Environment and Tourism, WWF LIFE Programme and the Namibia Nature Foundation. Species Report for Southern Savanna Buffalo

23. Reviewers: see #22 above

Compiler's Comments

For the consultant, completing the CAMP Taxon Data Sheet has not been an enjoyable task. A number of small irritations, which I list first, have cropped up at different places on the form. But there are larger issues at stake – which I summarise afterwards.

Detail

1. The title 'Conservation Assessment Management Plan' is meaningless jargon. The form required to be completed is neither a conservation assessment nor a management plan, let alone a hybrid of the two.
2. The rubric which goes with the form is patronising and assumes that anyone completing the form is likely to get it wrong.
3. This impression is reinforced by the annoying provision of little boxes to be ticked, especially when the binary-type categories do not suit the taxon in question.
4. The tone of document throughout is biassed heavily towards protection – which its authors seem to see as synonymous with conservation. For example –
    - In section 8, it is automatically assumed that trade is detrimental to species status. Question 8C allows of no possible benefits from trade and assumes that population decline is inevitable if the taxon is involved in trade.
    - In section 13H, there is an implied requirement for "Protection Plans" which, to the consultant, are not the same thing as plans designed to enhance the status of the species.
    - In section 17C, the demand is for a "Coordinated Species Management Programme" – as if, without such an important sounding document, one should not be dabbling in captive breeding.
5. In section 15, "sustainable utilisation" is given as one option amongst a set of management recommendations. Sustainability is synonymous with conservation and is the overarching goal under which all the other options should be placed. The narrow assumption that sustainable use automatically implies extractive use is stultifying.

But it is the unspoken 'process' embarked upon which is most depressing. One is left with the impression that conservation is in the care of a set of bewigged judges who, depending on the answers to the questions, will decide to which jail the species should be condemned.

The Larger Issues

In the 'essay' which follows, three main themes are pursued –

1. The subjectivity of the listing criteria;
2. The attempt to link conservation status inflexibly to management prescriptions;
3. The narrow conceptualisation of conservation.

These three themes are inextricably linked and I attempt to address them, not individually, but simultaneously and laterally through a narrative of certain events and experiences from the past few decades.

In 1992 there was growing dissatisfaction amongst Botswana, Malawi, Namibia, South Africa and Zimbabwe with the functioning of CITES. It was apparent that the criteria for listing species on the Appendices of CITES were inadequate and had resulted in many species being incorrectly listed (i.e. they were not on the brink of extinction and international trade had nothing to do with their status). These southern African nations submitted proposals for more rigorous criteria (SACIM 1992) based on the Minimum Viable Population approach of Mace and Lande (1991).[23] Interestingly, Mace and Lande had directed their writings not at CITES but at IUCN and were somewhat surprised when their proposals were applied to CITES by the southern African States. This may have provided the stimulus for IUCN to re-examine its Red Data Book criteria.

With some modifications, these criteria were adopted by CITES in 1994. They have made little difference to the CITES Appendices – these remain as subjective as ever (e.g. the African leopard remains listed on Appendix 1 despite the fact that the population numbers hundreds of thousands). However, the exercise served to demonstrate the fallacy of attempting to 'hard-link' management prescriptions to criteria of this sort. **The status of species is irrelevant to the management measures by which their populations may be increased**. Even very small populations (less than 100 animals) can sustain offtakes and, if such an offtake is likely to benefit the conservation of the species through re-investment of funds, there is no basis for prohibiting the particular transaction which would result in this improvement.

CITES problem is that it is a 'blueprint' treaty. It relies on listing species on Appendices and, having listed them, its prescriptions are inflexible. As long as CITES continues to operate under its present Articles it will act against the conservation of species more frequently than it will improve their status. In this respect it is identical to the United States Endangered Species Act which contains the same inflexible linkages between the perceived degree of endangerment and the management prescription. Holling and Meffe (1996) describe this as the 'Command and Control' syndrome. Soulé and Mills (1992) criticise the ESA for its emphasis on large charismatic species, its failure to bring about recoveries and for the fact that there is a backlog of species to be listed. I would submit that the Act has a more fundamental problem – until it separates the species conservation status label from the measures needed to enhance the species status, it will not have any beneficial impact on conservation.

The criteria used in the IUCN Red Data list are based upon consideration of Minimum Viable Populations (MVPs) – as were the proposals which the southern African States put to CITES. The lay reader is given the impression that there are generally agreed scientific criteria for deciding what endangered and vulnerable species are. There are no such absolutes (Martin 1999). Firstly, the categories 'Endangered', 'Vulnerable' and 'Threatened' are decided upon subjectively. Secondly, the numbers of species in each category depend entirely on the criteria adopted to define probabilities of extinction over various time spans.

The Minimum Viable Population needed to ensure the persistence of a population for a certain length of time is a statistical construct based on genetic and demographic properties and the environmental factors which may act upon the population. Generally, it is the assumptions

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23. This consultant drafted the proposals for the new criteria.

made about environmental variability which are the least reliable. The Effective Population Size (Ne) used in MVP calculations is the number of effective breeding animals in any population – which may be as little as 10% of the actual population size and is obviously species dependent. The typical criterion used is that population size should be large enough to ensure a probability of extinction less than a given threshold (e.g. less than a 1% likelihood in 100 years).

There is considerable disagreement amongst scientists over minimum effective population sizes and the methods used to derive the figures. In the 1960s, MacArthur and Wilson put forward numbers between 25-50; in the 1980s, the 50/500 rule was derived from genetic analyses (it was thought that an effective population size of 50 would provide some protection against short-term loss of fitness due to inbreeding, while a population of 500 would prevent loss of genetic variation over a longer term); the era of MVP hyperinflation began in the 1990s (10,000 to 1,000,000) based on effects of random fluctuations in environment. The practical implications of such figures do not bear inspection. For effective conservation of mountain lion, an area larger than that of the United States would be required.

MVPs can be estimated on genetic characters alone but this overlooks possibility of catastrophes and the interplay between population dynamics and loss of fitness due to inbreeding or genetic drift which could affect the ability of small populations to persist in a fluctuating environment. MVP criteria are expected to address all species simultaneously but one would still expect organisms with small body sizes to be more abundant than bigger organisms or they would be more likely to go extinct. There are significant differences between the genetic characters needed for short-term fitness and those needed for long term survival and the "bean-bag genetics" that have been applied in the new IUCN Red Data Book criteria do not take this into account.

If IUCN had sought no more than to remove subjectivity from their criteria for categorising the degree of threat to species one would have no quarrel with the objective. Accepting that the term 'Endangered' is itself a subjective construct, it is still desirable to have species of similar status included in the category. The problem comes when, in the same categorisation process, there is an attempt to link management requirements to the perceived degree of endangerment.

Inevitably, the graver the status of the species, the more draconian are the 'protection' measures advocated for its survival. Amongst the management recommendations in section 15 of the CAMP taxon assessment form there is little consideration given to socio-economic factors – which, in Africa, probably play the greatest part in determining the status of species. Requirements for species recovery may be completely counterintuitive. In Zimbabwe, the only species which have not increased in number since the 1970s are those which have remained legally 'protected' (e.g. black rhino, roan antelope). For the remainder, a combination of empowering landholders to manage their wildlife, removing constraints to trade and actively promoting economic value for species reversed the general declines in wildlife which were taking place on communal and commercial farmland and resulted in wildlife becoming a major form of land use.

The Red Data Book Criteria are imbued with the concept that there is a fixed quota of biological diversity and one can only deduct from that quota. Species populations which may be booming cannot be described as such; they are categorised as 'lower risk', 'conservation dependent' and 'least concern'. The doomsday scenario is self-perpetuating.

References to Appendix 1

Holling, C.S. and Gary K. Meffe (1996). **Command and Control and the Pathology of Natural Resource Management**. *Conservation Biology* 10(2): pp328-337

Mace, Georgina M. and Russell Lande (1991). **Assessing extinction threats: towards a re-evaluation of IUCN threatened species categories**. Conservation Biology 5: pp148-155

Martin R.B. (1999). **Biological Diversity: Divergent Views on its Status and Diverging Approaches to its Conservation**. In: *Earth Report 2000*, Editor Ron Bailey, McGraw-Hill, New York. pp203-236.

SACIM (1992). **Criteria for Amendments to the Appendices (The Kyoto Criteria**). Draft Resolution of the Conference of the Parties to CITES pursuant to Conf. 4.6 submitted by the Governments of Botswana, Malawi, Namibia and Zimbabwe. 22pp

Soulé, Michael E. and L. Scott Mills (1992). **Conservation genetics and conservation biology: a troubled marriage.** In: *Conservation of Biodiversity and Sustainable Development*. Scandinavian University Press, Oslo, 1992, pp55-69

FINANCIAL ANALYSIS OF SPORT HUNTING POTENTIAL IN CAPRIVI

Table A: Estimates of wildlife species numbers in the Caprivi

Year	Rodwell		Craig		Barnes		Average	Average
Species	No.	%	No.	%	No.	%	%	x 100
Buffalo	2,526	21.14	3,018	17.85	91	4.54	14.5	1,451
Bushbuck	–	0.00	–	0.00	–	0.00	0.0	0
Duiker	–	0.00	128	0.76	–	0.00	0.3	25
Eland	189	1.58	77	0.46	44	2.20	1.4	141
Elephant	5,556	46.50	7,950	47.02	419	20.92	38.1	3,815
Giraffe	76	0.64	360	2.13	26	1.30	1.4	135
Hippo	766	6.41	689	4.08	72	3.59	4.7	469
Impala	278	2.33	742	4.39	886	44.23	17.0	1,698
Kudu	551	4.61	280	1.66	151	7.54	4.6	460
Lechwe	1,109	9.28	2,009	11.88	6	0.30	7.2	715
Leopard	–	0.00	–	0.00	10	0.50	0.2	17
Lion	–	0.00	–	0.00	10	0.50	0.2	17
Reedbuck	93	0.78	173	1.02	–	0.00	0.6	60
Roan	67	0.56	–	0.00	25	1.25	0.6	60
Sable	452	3.78	613	3.63	–	0.00	2.5	247
Sitatunga	–	0.00	–	0.00	–	0.00	0.0	0
Steenbok	–	0.00	118	0.70	0	0.00	0.2	23
Tsessebe	28	0.23	153	0.91	31	1.55	0.9	90
Waterbuck	–	0.00	136	0.80	–	0.00	0.3	27
Warthog	–	0.00	293	1.73	137	6.84	2.9	286
Wildebeest (Blue)	–	0.00	–	0.00	13	0.65	0.2	22
Zebra (Burchell's)	257	2.15	167	0.99	82	4.09	2.4	241
TOTALS	11,948	100.00	16,906	100.00	2,003	100.00	100.0	

NOTES

1. The data in the first three columns are from (Rodwell *et al* 1995), ULG (1994) and Barnes (2001a and 2001b). The data for Barnes have been summed.
2. The aim of this exercise was to obtain rough proportions for the species numbers in the Caprivi Strip.
3. The numbers in the final column have been set so that the buffalo density is approximately 1.5 in 1,000km^2. Other densities are adjusted in the next table.
3. Smithers (1983) records Sharpe's Grysbok as occurring in the Caprivi Strip. It has not been included

in the above list.

Table B: Optimal stocking rates and hunting quotas for an area of 1,000km^2 in the Caprivi Strip

Factor 1.057 Species	Starting population	Densities(/km^2) Implied	Densities(/km^2) Adjusted	Model population	Unit LSU	Total LSUs	QUOTA %	QUOTA N
Buffalo	*1,451*	*1.45*	*1.50*	*1,500*	*see below*		–	–
Bushbuck	0	0.00	0.05	53	0.12	6.3	3	2
Duiker	25	0.03	1.00	1,057	0.08	84.6	3	32
Eland	141	0.14	0.25	264	1.00	264.3	2	5
Elephant	3,815	3.81	1.00	1,057	3.33	3519.8	1.5	16
Giraffe	135	0.14	0.05	53	1.34	70.8	5	3
Hippo	469	0.47	0.10	106	2.50	264.3	2	2
Impala	1,698	1.70	10.00	10,570	0.14	1479.8	3	317
Kudu	460	0.46	3.00	3,171	0.40	1268.4	2	63
Lechwe	715	0.72	1.00	1,057	0.16	169.1	3	32
Leopard	17	0.02	0.04	42	–	0.0	6	3
Lion	17	0.02	0.03	32	–	0.0	6	2
Reedbuck	60	0.06	0.10	106	0.14	14.8	3	3
Roan	60	0.06	0.25	264	0.65	171.8	2	5
Sable	247	0.25	0.25	264	0.40	105.7	2	5
Sitatunga	0	0.00	0.02	21	0.22	4.7	3	1
Steenbok	23	0.02	2.00	2,114	0.10	211.4	3	63
Tsessebe	90	0.09	0.25	264	0.27	71.3	3	8
Waterbuck	286	0.29	0.50	529	0.45	237.8	2	11
Warthog	27	0.03	2.00	2,114	0.18	380.5	3	63
Wildebeest (Blue)	22	0.02	0.10	106	0.40	42.3	3	3
Zebra (Burchell's)	241	0.24	0.20	211	0.63	133.2	5	11
					TOTAL LSUs	8500.8		650
					Ha/LSU	11.8		
BUFFALO				1,500	1.00	1500.0	3	45
					TOTAL LSUs	10000.8		
					Ha/LSU	10.0		

NOTES

1. The aim of this table is to create a 'model population' of large mammal species which would be typical for a well-stocked savanna system in an area of 1,000km^2 where rainfall is 500-600mm per annum. The population is that which might be expected in the central area of the Caprivi Strip around the Kwando River and relates to the 'core' wildlife range.
2. The first column is taken from Table A but it is for note only, as are the 'implied' densities derived from it, since all of the smaller species numbers will have been underestimated in the aerial census. The 'adjusted' densities are based on experience from similar savannas.
3. The buffalo population is fixed at density of 1.5 which is the roughly the expected carrying capacity for this rainfall (see Main Report, page 12).
4. The 'Model Population' is obtained by multiplying the 'adjusted' densities by 1,000 and by the factor in the top left hand corner of the table which has been selected so that the total stocking density is 1LSU/10ha, including the buffalo population at carrying capacity.
5. Unit livestock biomass values are the same as those used by Barnes and de Jager (1995)

6. The quota percentages are typical for safari hunting in southern Africa being adjusted upwards when trophy quality is less critical (e.g Zebra - 5%) and downwards where high trophy quality is the aim (e.g. sable - 2%).

Table C: Trophy fees and quota value

Species	Quota	*Trophy fee - H*	Trophy Fee	Quota value	#
Premier Species					
ELEPHANT	16	7,500	7,500	120,000	***16***
BUFFALO	45	–	5,000	225,000	***45***
LION	2	6,500	5,000	10,000	***2***
HIPPO	2	5,000	5,000	10,000	***2***
LEOPARD	3	2,750	3,000	9,000	***3***
Plains Game - A					***11***
Roan	5	6,300	3,000	15,000	
Sable	5	5,500	3,000	15,000	
Sitatunga	1	–	3,000	3,000	
Plains Game - B					***111***
Eland	5	1,496	1,500	7,500	
Giraffe	3	1,400	1,500	4,500	
Lechwe	32	1,225	1,500	48,000	
Tsessebe	8	–	1,500	12,000	
Waterbuck	63	2,000	1,500	94,500	
Plains Game - C					***82***
Bushbuck	2	–	750	1,500	
Kudu	63	783	750	47,250	
Reedbuck	3	–	750	2,250	
Wildebeest (Blue)	3	1,003	750	2,250	
Zebra (Burchell's)	11	690	750	8,250	
Plains Game - D					***423***
Impala	317	585	375	118,875	
Duiker	32	231	375	12,000	
Steenbok	63	275	375	23,625	
Warthog	11	375	375	4,125	
		TOTAL TROPHY FEE VALUE US$		**793,625**	

NOTES

1. The quota in the first column is taken from **Table B**.
2. The trophy fees listed in the second column are the high values from Himavundu (2001).
3. For simplicity in packaging the hunts (see following tables), the trophy fees have been averaged and rounded over groups of animals. The slightly increased values allow for price escalation since 2000.
4. The value of sable, roan, impala and wildebeest trophy fees given by Himavundu (2001) are very much higher than the regional average and have been adjusted downwards for the Caprivi Strip.

HUNT PACKAGING

Table D: Packaging of Hunts with maximum buffalo available

						Plains Game			
	Elephant	Buffalo	Lion	Leopard	Hippo	A	B	C	D
Quota	16	45	2	3	2	11	111	82	423
Trophy fee	7,500	5,000	5,000	3,000	5,000	3,000	1,500	750	375

	Big Game Safaris	Elephant Buffalo & Cat Hunts	Elephant & Buffalo Hunts	Buffalo Hunts	Premier Plains Game	Plains Game Hunts	Biltong Hunts	TOTALS
Number of hunts	2	1	13	29	9	9	11	74
Elephant	2	1	13					16
Buffalo	2	1	13	29				45
Lion	2	0						2
Leopard	2	1						3
Hippo	2							2
Plains Game species - A	2				9			11
Plains Game species - B	6	3	26	58	9	9	0	111
Plains Game species - C	6	3	26	29	9	9	0	82
Plains Game species - D	12	6	65	145	36	45	110	419
Safari days	21	18	14	10	8	7	5	
Total Hunter days	42	18	182	290	72	63	55	722
Daily rates	1,500	1,250	1,000	750	500	250	100	
Gross income daily rates	63,000	22,500	182,000	217,500	36,000	15,750	5,500	542,250
Trophy fees	75,000	24,500	245,375	308,125	60,750	37,125	20,625	771,500
GROSS INCOME	138,000	47,000	427,375	525,625	96,750	52,875	26,125	1,313,750
					Gross income/hectare			**13.14**

ASSUMPTIONS

1. A Big Game Safari is a 21 day hunt at a daily rate of US$1,500/day. It includes an elephant, 1 buffalo, both large cats, 1 hippo, 1 Category A, 3 Category B, 3 Category C and 6 Category D Plains Game species (which includes an allowance for baits for the cats).
2. An Elephant, Buffalo & Cat Hunt is an 18 day safari at a daily rate of US$1,250 day. It includes an elephant, 1 buffalo, 1 large cat, 3 Category B, 3 Category C and 6 Category D Plains Game species (which includes an allowance for baits for the cat).
3. An Elephant and Buffalo Hunt is a 14 day safari at a daily rate of US$1,000 day. It includes an elephant, a buffalo, 2 Category B, 2 Category C and 5 Category D Plains Game species.
4. A Buffalo hunt is a 10 day safari at a daily rate of US$750/day. It includes a buffalo, 2 Category B, 1 Category C and 5 Category D Plains Game species.
5. A Premier Plains Game safari is an 8 day hunt at US$500/day which includes 1 Category A, 1 Category B, 1 Category C and 4 Category D Plains Game species. If there are insufficient Premium Plains Game trophies on quota, 2 Large Plains Game trophies are sold as a substitute.
6. A Plains Game safari is a 7 day hunt at US$250/day which includes 1 Category B, 1 Category C and 5 Category D Plains Game species.
7. The remaining animals are sold on 5 day Biltong Hunts at US$100/day. The typical number of animals expected to be taken on a Biltong Hunt is 6 and the trophy fees are halved.

6\. All hunts are assumed to be carried out by a single client.

7\. All financial amounts are in United States dollars.

Table E: Packaging of Hunts with minimum buffalo available

							Plains Game		
	Elephant	Buffalo	Lion	Leopard	Hippo	A	B	C	D
Quota	16	7	2	3	2	11	111	82	423
Trophy fee	7,500	5,000	5,000	3,000	5,000	3,000	1,500	750	375

	Big Game Safaris	Elephant Buffalo & Cat Hunts	Elephant & Buffalo Hunts	Elephant Bull Hunts	Premier Plains Game	Plains Game Hunts	Biltong Hunts	TOTALS
Number of hunts	2	1	4	9	9	47	8	80
Elephant	2	1	4	9				16
Buffalo	2	1	4					7
Lion	2	0						2
Leopard	2	1						3
Hippo	2							2
Plains Game species - A	2				9			11
Plains Game species - B	6	3	8	18	9	47	20	111
Plains Game species - C	6	3	8	9	9	47	0	82
Plains Game species - D	12	6	20	45	36	235	60	414
Safari days	21	18	14	10	8	7	5	
Total Hunter days	42	18	56	90	72	329	40	647
Daily rates	1,500	1,250	1,000	750	500	250	100	
Gross income daily rates	63,000	22,500	56,000	67,500	36,000	82,250	4,000	331,250
Trophy fees	75,000	24,500	75,500	118,125	60,750	193,875	26,250	574,000
GROSS INCOME	138,000	47,000	131,500	185,625	96,750	276,125	30,250	905,250
						Gross income/hectare		**9.05**

ASSUMPTIONS

1. The present 'core area' for buffalo is 5,250km^2 of which approximately 1,250km^2 is in non-hunting State protected areas. The assumed buffalo population in the core areas outside State protected areas is 1,000 in about 4,000km^2 or 250 per 1,000km^2. A 3% quota of this population is 7 animals/1,000km^2.
2. A Big Game Safari is a 21 day hunt at a daily rate of US$1,500/day. It includes an elephant, 1 buffalo, both large cats, 1 hippo, 1 Category A, 3 Category B, 3 Category C and 6 Category D Plains Game species (which includes an allowance for baits for the cats).
3. An Elephant, Buffalo & Cat Hunt is an 18 day safari at a daily rate of US$1,250 day. It includes an elephant, 1 buffalo, 1 large cat, 3 Category B, 3 Category C and 6 Category D Plains Game species (which includes an allowance for baits for the cat).
4. An Elephant and Buffalo Hunt is a 14 day safari at a daily rate of US$1,000 day. It includes an elephant, a buffalo, 2 Category B, 2 Category C and 5 Category D Plains Game species.
5. A Elephant Bull hunt is a 10 day safari at a daily rate of US$750/day. It includes an elephant, 2 Category B, 1 Category C and 5 Category D Plains Game species.
6. A Premier Plains Game safari is an 8 day hunt at US$500/day which includes 1 Category A, 1 Category B, 1 Category C and 4 Category D Plains Game species. If there are insufficient Premium Plains Game trophies on quota, 2 Large Plains Game trophies are sold as a substitute.
7. A Plains Game safari is a 7 day hunt at US$250/day which includes 1 Category B, 1 Category C and 5 Category D Plains Game species.
8. The remaining animals are sold on 5 day Biltong Hunts at US$100/day. The typical number of animals expected to be taken on a Biltong Hunt is 6 and the trophy fees are halved.

6. All hunts are assumed to be carried out by a single client.
7. All financial amounts are in United States dollars.

Table F: Calculation of Operating Costs for 250 km^2 *All figures are in United States dollars*

CAPITAL (Capital costs are depreciated over 5 years and added to operating costs)

#	ITEM	Quantity	Unit Cost US$	Amounts	Totals
1	**Vehicles**				
2	4x4	5	20,000	100,000	
3	Fuel Storage	1	250	250	
4	Tools	1	500	500	
5	Vehicle Spares	1	1,000	1,000	101,750
6	**Accommodation**				
7	Clients	3	1,000	3,000	
8	Staff - senior	4	500	2,000	
9	Staff - junior	17	200	3,400	
10	Bathrooms	6	200	1,200	
11	Kitchen	1	500	500	
12	Dining Room	1	300	300	10,400
13	**Equipment**				
14	Refrigerators	2	300	600	
15	Deep Freeze	1	300	300	
16	Furniture	1	300	300	
17	Pots, pans, cutlery, crockery	1	500	500	
18	Lighting	1	1,500	1,500	3,200
19	Water supply	1	1,500	1,500	1,500
20				TOTAL	116,850
21	**CAPITAL: Amount to be recovered annually**				**23,370**
22	**OPERATING COSTS**				
23	**Staff salaries** (costs are for 6 month hunting season)				
24	Professional Hunter US$/day	180	200	36,000	
25	Learner Hunter	1	4,000	4,000	
26	Camp Manager	1	3,000	3,000	
27	Cooks	2	1,000	2,000	
28	Waiters	2	500	1,000	
2	Scouts	5	300	1,500	

29							
30		Skinners		2	400	800	
31		Trackers		2	400	800	
32		Driver		1	500	500	
33		PR/Community relations		1	2,000	2,000	
34		General workers		3	200	600	52,200
35	**Vehicles**						
36		Fuel (litres)		10,000	1	10,000	
37		Lubricants (litres)		100	5	500	10,500
38	**Camp**						
39		Annual refurbishment		1	5,000	5,000	
40		Gas (kg)		200	5	1,000	
41		Miscellaneous		1	1,000	1,000	7,000
42	**Food and drink**						
43		Clients (2)	US$/day	180	50	9,000	
44		Senior staff (4)		180	20	3,600	
45		Junior Staff (17)		180	20	3,600	16,200
		Total annual operating costs for 250km^2, including capital replacement					**109,270**
						Annual operating costs/ha	**4.37**

NOTES on Table F (row number references)

The reason operating costs have been calculated for an area of 250 km^2 is because the total number of 722 hunter days in 1,000 km^2 (Table D) justify 4 hunting outfits each with approximately 180 hunter days. In the case with a reduced buffalo complement, the 4 hunting outfits are still justifiable for 647 hunter days.

2. Vehicles are for (a) Professional hunter (b) Learner hunter (c) Camp manager (d) PR officer (e) Standby
4. All vehicle maintenance is done on site. Provision for tyres, tubes etc is included under spares.
6. Rustic or tented accommodation will be used for the hunting camp
7. Provision has been made for up to three clients
18. Lighting includes a 25kva generator
19. Water supply includes 2 pumps, watertank and piping
21. All capital items are written off over 5 years and the total capital cost is included in the operating costs
24. The professional hunter is paid on a daily rate of US$200/day for actual days hunted
29. Scouts are used for anti-poaching in 250km^2
36. Fuel provision includes generator and water pumps.
39. 'Annual refurbishment' includes camp maintenance costs during the hunting season and at start-up each year
40. Gas is used in the kitchen for cooking
41. 'Miscellaneous' camp operating costs includes cleaning materials, toilet paper, cooking oils, salt, pepper, sauces, napkins etc.
42. All staff are fed whilst in the field

For the purposes of this exercise, all extra charges such as government tourism levies, CITES tags and documentation, transfers to hunting camps etc. are assumed to be passed on to the client with no mark-ups.

Table G: COST AND LAND USE SUMMARY

	WITH PRESENT BUFFALO DENSITY	WITH BUFFALO AT CARRYING CAPACITY
Area	4000 km^2	4000 km^2
Buffalo Density	0.25/km^2	1.5/km^2
Gross income US$/hectare	9.05	13.14
Operating costs US$/hectare	4.37	4.37
Net income US$/hectare	4.68	8.77
Potential earnings from 4,000sq.km	1,872,680	3,506,680

NOTES

1. The present 'core wildlife area' in the Caprivi Strip is 5,250km^2 of which approximately 1,250km^2 is in non-hunting State protected areas. Therefore these calculations pertain to a potential prime area for buffalo of 4,000km^2. It is assumed that the present buffalo density outside the non-hunting State protected areas is about 0.25 per km^2 and this could be raised to 1.5 per km^2.
2. Gross income is calculated in Tables D & E.
3. Operating costs are calculated in Table F.
4. This net income includes no payments to government or local communities for the safari concession. However, the net income to the safari operator indicates the margins available for these payments.

FINANCIAL ANALYSIS OF BUFFALO POTENTIAL ON COMMERCIAL FARMS

Table A: Estimates of wildlife species numbers for all private farms in 1972, 1992 and 2002

Year Species	**1972** Number	**1992** Number	**2002** Number	**Density** 356,886km^2	**Number in 1,000km^2**
Black wildebeest	-	7,177	9,639	0.03	27
Black-faced impala	-	2,144	2,879	0.01	8
Blue wildebeest	326	4,935	6,628	0.02	19
Dik-dik	13,011	15,783	21,197	0.06	59
Duiker	84,419	75,518	101,421	0.28	284
Eland	10,338	29,150	39,148	0.11	110
Gemsbok	55,406	164,306	220,663	0.62	618
Giraffe	3,760	4,552	6,113	0.02	17
Hartebeest	16,302	50,804	68,230	0.19	191
Impala	1,006	4,919	6,606	0.02	19
Klipspringer	29,509	22,879	30,726	0.09	86
Kudu	148,211	203,087	272,746	0.76	764
Hartmann’s zebra	22,531	34,398	46,197	0.13	129
Nyala	–	96	129	0.00	0
Burchell’s zebra	1,214	4,170	5,600	0.02	16
Reedbuck	-	2,303	3,093	0.01	9
Roan	-	633	850	0.00	2
Sable	-	6,804	9,138	0.03	26
Springbok	221,955	286,113	384,250	1.08	1077
Steenbok	18,741	138,941	186,598	0.52	523
Tsessebe	-	1,564	2,100	0.01	6
Warthog	67,207	121,250	162,839	0.46	456

NOTES

1. The first 3 columns are from Barnes and de Jager (1995, Table 1)
2. The estimates for 2002 are obtained by extrapolation of a general rate of increase of 3%/year

Table B: Derivation of hunting quotas for an area of 1,000km^2 in northern Namibia

Species	2002 Number	Model population	Unit LSU	Total LSUs	QUOTA %	QUOTA N
Black wildebeest	9,639	110	0.27	29.7	4	4
Black-faced impala	2,879	33	0.14	4.6	3	1
Blesbok	5,000	57	0.17	9.7	3	2
Blue wildebeest	6,628	76	0.40	30.2	4	3
Dik-dik	21,197	242	0.04	9.7	3	7
Duiker	101,421	1,157	0.08	92.6	3	35
Eland	39,148	447	1.00	446.7	2	9
Gemsbok	220,663	2,518	0.40	1007.1	2	50
Giraffe	6,113	70	1.34	93.5	5	3
Hartebeest	68,230	779	0.25	194.6	3	23
Impala	6,606	75	0.14	10.6	3	2
Klipspringer	30,726	351	0.06	21.0	3	11
Kudu	272,746	3,112	0.40	1244.8	3	93
Hartmann's zebra	46,197	527	0.60	316.3	5	26
Burchell's zebra	5,600	64	0.63	40.3	5	3
Sable	9,138	104	0.40	41.7	2	2
Springbok	384,250	4,384	0.10	438.4	4	175
Steenbok	186,598	2,129	0.06	127.7	3	64
Tsessebe	2,100	24	0.27	6.5	3	1
Warthog	162,839	1,858	0.18	334.4	3	56
			TOTAL LSUs	4500.1		570
			Ha/LSU	22.2		
BUFFALO		500	1.00	500.0	3	15
			TOTAL LSUs	5000.1		
			Ha/LSU	20.0		
Leopard	–	20	–	–	6	1
Cheetah	–	20	–	–	6	1

NOTES

1. Since the numbers of animals on a single farm of about 8,000 ha derived from an overall average of all farms in Namibia suffer from rounding errors and are too low to provide hunting quotas for all but a few species, this was rejected as a basis for deriving a model population. It is reasonable to expect that some farms will have invested more than others in building up wildlife numbers.
2. The method used was to consider 1,000km^2 of land assumed to be preferentially set up for wildlife (i.e. cattle numbers would be low) and to stock it at a rate of 1LSU/20ha including a buffalo population at carrying capcity. Under the rainfall conditions in northern Namibia, this area of land could carry approximately 500 buffalo (500 LSUs). The numbers of the other wildlife species populations in the first column (taken from Table A) were then multiplied by a factor (0.0141) such that the final stocking rate, including the buffalo population, was exactly equal to 1LSU/20ha.
3. Unit livestock biomass values are the same as those used by Barnes and de Jager (1995)
4. Blesbok, Cheetah and Leopard have been added to the species list of Barnes and de Jager (1995) because the data of Himavundu (2001) indicate that these are commonly hunted. Nyala and roan have been deleted from the list because their numbers would be too low to provide a quota in 1,000km^2 by this method. Minor

species such as baboons and dassies have been omitted.

5. The quotas proportions used are typical for large mammal hunting in southern Africa being adjusted upwards when trophy quality is less critical (e.g Zebra - 5%) and downwards where high trophy quality is an objective (e.g. sable - 2%).

Table C: Trophy fees and quota value

Species	Quota	*Trophy fee - H*	Trophy Fee	Quota value	#
BUFFALO	15	–	6,000	90,000	***15***
Specialty hunts					***4***
Sable	2	5,500	3,000	6,000	
Leopard	1	2,750	3,000	5,000	
Cheetah	1	2,250	3,000	5,000	
Premium Plains Game Species					***27***
Eland	9	1,496	1,500	13,500	
Giraffe	3	1,400	1,500	4,500	
Black wildebeest	4	1,225	1,500	6,000	
Dik-dik	7	1,150	1,500	10,500	
Black-faced impala	1	–	1,500	1,500	
Blue wildebeest	2	1,003	1,500	3,000	
Tsessebe	1	–	1,500	1,500	
Large Plains Game Species					***220***
Kudu	93	783	750	69,750	
Hartmann's zebra	26	725	750	19,500	
Burchell's zebra	26	690	750	19,500	
Hartebeest	23	625	750	17,250	
Impala	2	585	750	1,500	
Gemsbok	50	539	750	37,500	
Small Plains Game Species					***343***
Blesbok	2	445	375	750	
Springbok	175	380	375	65,625	
Warthog	56	375	375	21,000	
Klipspringer	11	300	375	4,125	
Steenbok	64	275	375	24,000	
Duiker	35	231	375	13,125	
		TOTAL TROPHY FEE VALUE US$		**440,125**	

NOTES

1. The quota in the first column is taken from **Table B**.
2. The trophy fees listed in the second column are the high values from Himavundu (2001).
3. For simplicity in packaging the hunts (see following tables), the trophy fees have been averaged and rounded over groups of animals. The slightly increased values allow for price escalation since 2000.

4. The value of a sable trophy fee given by Himavundu (2001) is very much higher than the regional average and may temporarily reflect a scarcity value in Namibia.

HUNT PACKAGING

Table D: Packaging of Hunts with buffalo available

	Buffalo	Specialty Species	Premium Plains Game	Large Plains Game	Small Plains Game
Quota	15	4	27	220	343
	Buffalo Hunts	Sable and Cat Hunts	Plains Game Hunts	Biltong Hunts	TOTALS
Number of hunts	15	4	36	19	74
Premium Plains Game species	15	4	8	–	27
Large Plains Game species	45	8	164	3	220
Small Plains Game species	75	12	144	111	342
Hunter days	210	40	288	57	595
Daily rates	500	400	300	100	
Gross income daily rates	105,000	16,000	86,400	5,700	213,100
Trophy fees	174,375	28,500	189,000	21,938	413,813
GROSS INCOME	279,375	44,500	275,400	27,638	626,913
Gross income/hectare					6.27
Fixed costs/ha					2.50
Variable costs					2.50
Net income/ha					1.27

ASSUMPTIONS

1. A Buffalo hunt is a 14 day safari at a daily rate of US$500/day. In addition to the buffalo, 1 Premium Plains Game trophy, 3 Large Plains Game trophies and 5 Small Plain Game trophies will be taken.
2. A Sable or Cat hunt will is a 10 day safari at a daily rate of US$400/day. In addition to the specialty trophy, 1 Premium Plains Game trophy, 2 Large Plains Game trophies and 3 Small Plains Game trophies will be taken.
3. A Plains Game hunt is an 8 day safari at US$300/day which includes 1 Premium Plains Game trophy, 3 Large Plains Game trophies and 4 Small Plains Game trophies. If there are insufficient Premium Plains Game trophies on quota, 2 Large Plains Game trophies are sold as a substitute.
4. Surplus animals are sold on 3 day Biltong Hunts at US$100/day. The typical number of animals expected to be taken on a Biltong Hunt is 6 and the trophy fees are halved.
5. It is assumed that there will always be enough Premium Large and Small Plains Game animals on quota to support the Buffalo, Sable and Cat hunts.
6. All hunts are assumed to be carried out by a single client.
7. All financial amounts are in United States dollars.
8. Fixed costs: Barnes and de Jager (1995) give the fixed costs for typical northern farms as US$4.59/ha. However, this figure includes various allowances for loan amortisation, interest on capital, etc. and the proportion required for this analysis is simply the fixed overhead annual operating costs which are about 40% of the total fixed costs (Barnes 2002a, 2002b), i.e. about US$1.84/ha. Allowing for US$ cost increases since 1995 at a rate of 3% annum gives a 2002 value for annual operating costs of US$2.33/ha (rounded up to US$2.5 in the table above).
9. Variable costs: Barnes and de Jager (1995) give the fixed costs for typical northern farms as US$1.89/ha. . Allowing for US$ cost increases since 1995 at a rate of 3% annum gives a 2002 value for annual operating costs of US$2.39/ha

(rounded up to US$2.5 in the table above).

Table E: Packaging of Hunts with no buffalo available

	Buffalo	Specialty Hunts	Premium Plains Game	Large Plains Game	Small Plains Game
Quota	0	4	27	220	343
	Buffalo Hunts	Sable and Cat Hunts	Plains Game Hunts	Biltong Hunts	TOTALS
Number of hunts	0	4	51	21	76
Premium Plains Game species	0	4	23	–	27
Large Plains Game species	0	8	209	3	220
Small Plains Game species	0	12	204	123	339
Hunter days	0	40	408	63	511
Daily rates	500	400	300	100	
Gross income daily rates	0	16,000	122,400	6,300	144,700
Trophy fees	0	28,500	267,750	24,188	320,438
GROSS INCOME	0	44,500	390,150	30,488	465,138
Gross income/hectare					4.65
Fixed costs/ha					2.50
Variable costs					2.50
Net income/ha					-0.35

ASSUMPTIONS

1. A Sable or Cat hunt will is a 10 day safari at a daily rate of US$400/day. In addition to the specialty trophy, 1 Premium Plains Game trophy, 2 Large Plains Game trophies and 3 Small Plains Game trophies will be taken.
2. A Plains Game hunt is an 8 day safari at US$300/day which includes 1 Premium Plains Game trophy, 3 Large Plains Game trophies and 4 Small Plains Game trophies. If there are insufficient Premium Plains Game trophies on quota, 2 Large Plains Game trophies are sold as a substitute.
3. Surplus animals are sold on 3 day Biltong Hunts at US$100/day. The typical number of animals expected to be taken on a Biltong Hunt is 6 and the trophy fees are halved.
4. It is assumed that there will always be enough Premium Large and Small Plains Game animals on quota to support the Sable and Cat hunts.
5. All hunts are assumed to be carried out by a single client.
6. All financial amounts are in United States dollars.
7. Fixed costs: Barnes and de Jager (1995) give the fixed costs for typical northern farms as US$4.59/ha. However, this figure includes various allowances for loan amortisation, interest on capital, etc. and the proportion required for this analysis is simply the fixed overhead annual operating costs which are about 40% of the total fixed costs (Barnes 2002a, 2002b), i.e. about US$1.84/ha. Allowing for US$ cost increases since 1995 at a rate of 3% annum gives a 2002 value for annual operating costs of US$2.33/ha (rounded up to US$2.5 in the table above).
8. Variable costs: Barnes and de Jager (1995) give the fixed costs for typical northern farms as US$1.89/ha. . Allowing for US$ cost increases since 1995 at a rate of 3% annum gives a 2002 value for annual operating costs of US$2.39/ha (rounded up to US$2.5 in the table above)

Protected Area Requirements in Southern Africa

Martin (1996) empirically derived the relationship that the number of men required for effective patrolling against illegal hunting in any park was approximately equal to the square root of the area of the park. The relationship was based on the relative success of the different protected areas in Zimbabwe using the criterion that, under effective patrolling, illegal hunters will be found within less than two days.

$$\textit{Number of men:} \quad N_S = \sqrt{A}$$

— where A is expressed in square kilometres

PARK SIZE km^2	1	5	10	50	100	500	1,000	5,000	10,000
NUMBER OF MEN	1	2	3	7	10	22	32	71	100

Martin (1997) developed standard spreadsheets for calculating the operating costs and capital requirements based on this relationship. The number of men determines the annual running cost for any park. The budget is made up of salaries, field allowances, equipment, transport and maintenance costs and includes provisions for senior field and research staff. Allowing for variations in salaries and fuel costs from country to country in the region, the operational costs are approximately given by the formula —

$$\textit{Annual Recurrent Expenditure/km}^2 \quad C_R = US\$50\ (1 + 2/A + 3/\sqrt{A})$$

The capital requirements to set up a new park from scratch are also dependent on the total staff complement in the park and vary slightly depending on building costs across the region. The required capital per unit area is approximately given by —

$$\textit{Total Capital Expenditure/km}^2 \quad C_C = US\$500\ (1 + 1/A + 1/\sqrt{A})$$

— where A is expressed in thousands of square kilometres in both formulas

STAFF NUMBERS, OPERATING COSTS AND CAPITAL REQUIREMENTS FOR VARIOUS PARK SIZES

PARK SIZE km^2	Number of Field Staff Required	Operating Costs US$/km^2/year	Total Operating Cost US$/year	Capital Required US$/km^2	Total Capital US$
1	1	104,793	104,793	516,311	516,311
2	1	53,404	106,808	261,680	523,361
5	2	22,171	110,857	107,571	537,855
10	3	11,550	115,500	55,500	555,000
20	4	6,111	122,213	29,036	580,711
50	7	2,721	136,041	12,736	636,803
100	10	1,524	152,434	7,081	708,114
200	14	885	177,082	4,118	823,607
500	22	462	231,066	2,207	1,103,553
1,000	32	300	300,000	1,500	1,500,000
2,000	45	206	412,132	1,104	2,207,107
5,000	71	137	685,410	824	4,118,034

10,000	100	107	1,074,342	708	7,081,139
20,000	141	89	1,770,820	637	12,736,068
50,000	224	73	3,660,660	581	29,035,534
100,000	316	66	6,600,000	555	55,500,000

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