Caprivi Elephant Monitoring Project

DRAFT FINAL REPORT

(October 1992 to October 1995

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1.0 BACKGROUND

The following report is submitted as a **draft** final technical report for the Caprivi Elephant Conservation component of the project for "Monitoring and Managing the East and West Caprivi Natural Resource Base for Increased Productivity and Sustainable Utilization". This component of the Caprivi LIFE (Life in a Finite Environment, USAID) project is the continuation of the three year elephant conservation project known as the Caprivi Elephant Monitoring Project. The project was begun in October 1992, funded by the EU and MET, and is now funded by USAID LIFE funds and the MET. This draft final report is submitted as a conclusion of the previous six progress reports submitted from October 1992 to June 1995.

As stated in the original project proposal in 1992, I will be using components of this Caprivi elephant research as the basis for a Ph.D. dissertation at the Universtity of California, Davis (UCD). This report is a **draft** of the final report. Once comments from project supervisors have been received, and aspects of the research not yet completed, have been analysed, the final document will be submitted to the MET and WWF. Aspects of the research not fully addressed in the final report will be submitted as scientific publications, and a final dissertation document. Future publications in scientific journals concerning aspects of my research in Namibia will be submitted to the MET for comment before they are published.

2. 0 INTRODUCTION

The Caprivi region of Namibia with its perennial rivers and relatively high rainfall (600-700 mm), contains most of the riverine and woodland habitats of an otherwise arid to semi-arid country. Due to this environment, and its proximity to large herds of free ranging wildlife species in Botswana and Zimbabwe, Caprivi has the potential to hold some of the highest densities and diversity of wildlife in Namibia. Past events in Caprivi, however, including uncontrolled hunting, poaching, and most importantly ,competition between humans and wildlife for living space, have contributed to a precipitous decline of many species, particularly in East Caprivi.

In an otherwise resource-poor part of Namibia, the Caprivi, has significant potential for the establishment of a local economy based on its rich but threatened wildlife resources.
In order to establish successful resource use programs, however, the wildlife needs to be better understood and managed. Of the wildlife resources available in the Caprivi, elephants occur in the highest densities and over the widest range, and they presently generate more revenue for the government of Namibia than any other wildlife species in the Caprivi. This population of elephants is thought to be part of a larger population centred in northern Botswana, and western Zimbabwe, and cross-border movements occur frequently.

The elephant range in adjacent countries largely falls within areas of low human density. In contrast, elephant range in the Caprivi is shared with a relatively large human community dependent on subsistence crops and shared water resources.

Conservation areas in the Caprivi are small, and possibly inadequate to act as refuges for large numbers of elephants. Regular movement of elephants into the surrounding cultivated and inhabited lands, creates the highest incidence of elephant-human conflicts in Namibia.

If the elephants are to remain in Caprivi where they are surrounded by human communities, their economic value needs to be maximised, and their costs to the surrounding rural communities needs to be reduced. Increasing the benefit of elephants in this region means these populations need to be managed and utilised as a consumptive and non-consumptive resource. In order to manage this utilisation sustainably, the demography, numbers and movements of this population of elephants needs to be understood, and land management plans of Caprivi needed to formulated to take both the wildlife and human community needs into account.

3.0 OBJECTIVES

As most of the elephants of Caprivi appear to be seasonal inhabitants, any plans to manage these elephants effectively needs to be based on understanding where, when and why they move regionally, and in order to manage and utilize these elephants while they are in Caprivi it is important to understand the total numbers, distribution and demography of the populations when they are in Caprivi.

With these objectives in mind, the following goals were established for the Caprivi Elephant Monitoring Project:

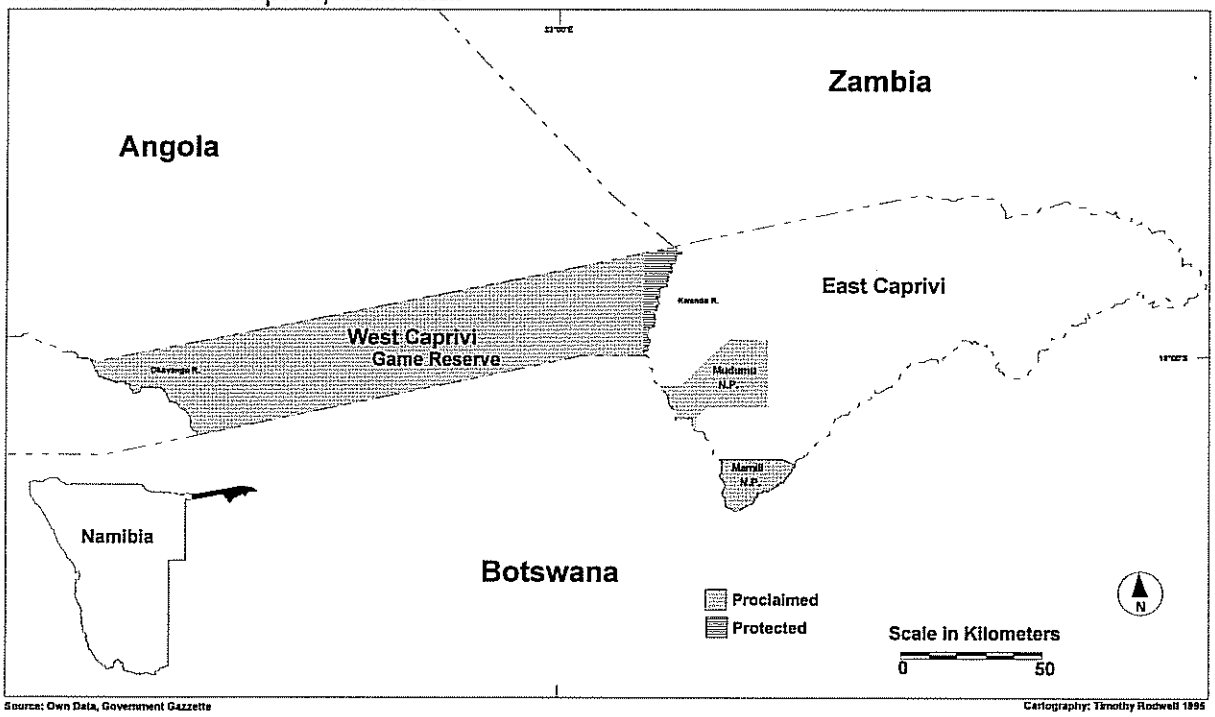
- Estimate the size and seasonal distribution of Caprivi elephant populations.
- Establish the extent and timing of elephant movements.
- Analyse elephant herd age structure and mortalities.
- Analyse present elephant trophy hunting in Caprivi.
- Provide training to MET and community conservation staff to enable the continuation of aspects of the elephant research in Caprivi.

4.0 STUDY AREA

The Caprivi region of Namibia is bordered in the west by the perennial Okavango River[1], and in the east by the Chobe and Zambezi Rivers. It is also surrounded by the countries of Angola and Zambia in the north, and Botswana and Zimbabwe in the south and east respectively. The Caprivi is further divided geographically by the Kwando River into the West and East Caprivi. It is a relatively flat land area, with an average altitude of 1000m ±60m.

There are at present three protected areas in Caprivi: West Caprivi Game Reserve, Mudumu National Park and Mamili National Park (Fig. 1). The climate of the Caprivi is considered subtropical with an annual rainfall of about 600-700mm, a dry winter, and hot, wet summer (Erkkila & Siiskonen 1992).

Figure 1: Current National Park, Game Reserve and protected area boundaries in the East and West Caprivi, Namibia.



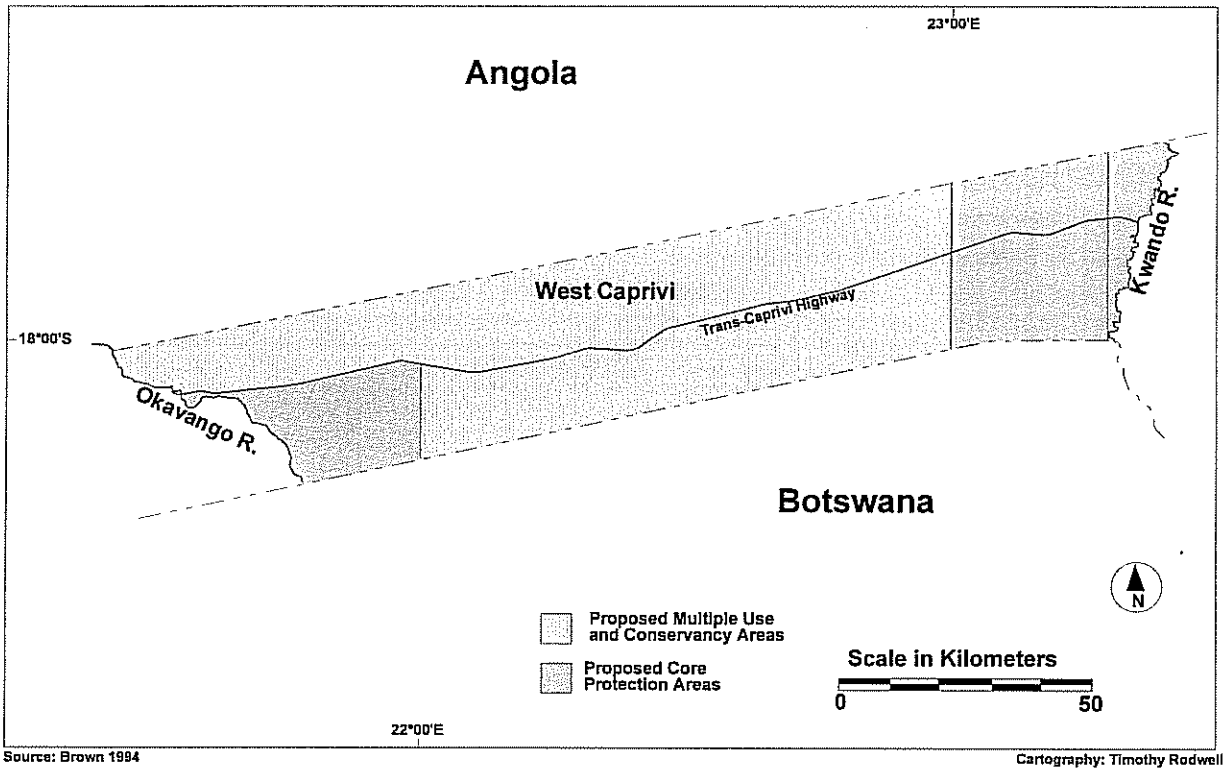
4.1 West Caprivi

The West Caprivi Game Reserve (WCGR) includes almost all of the approximately 5715 km^2 of West Caprivi, except for a small triangle of land along the Kwando River (Fig. 1), which although not included in the Game Reserve, is administered by the Namibian MET. The WCGR has had a confusing history, which includes occupation by the South African Defense Force (SADF) from the early 1960's to 1989. The West Caprivi Nature Park was proclaimed in 1963, and upgraded to a Game Reserve in

[1] This definition of the Western regional boundary of Caprivi refers to the situation at the time of the census design.

1968. It has included rural human settlements among its wildlife populations throughout its history, and at present there are approximately 4,500 people within the WCGR (Brown & Jones 1994). The presence of rural communities in the WCGR has made administration of this area as a game reserve, extremely complicated, and as a result, it is presently under scrutiny for partial de-proclamation (Fig. 2). There is strong motivation to establish two core regions of complete protection on the west and east ends of the West Caprivi, while converting the remaining area to one in which multiple land use programmes and conservancies could be established (Jones 1995).

Figure 2: Proposed land reforms for the West Caprivi.



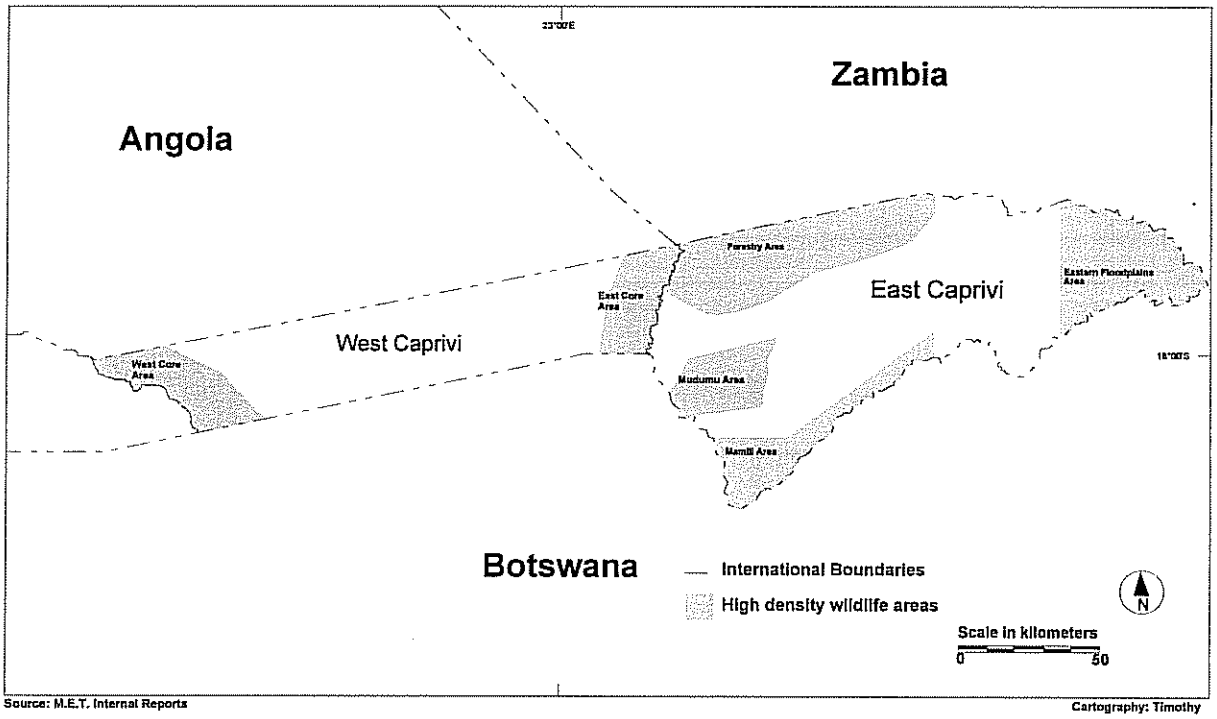
The West Caprivi is made up primarily of three physiographic features; 1) perennial Kavango and Kwando rivers with their associated floodplains and riparian vegetation, 2) a parallel system of drainage lines (Omirumba) tending south east containing mostly grasslands, and 3) deep Kalahari sands forming dunes supporting woodland savanna mostly of a mixed Baikiaea composition. The only permanent water is in the perennial rivers, with seasonal rain-filled pans forming in the omirumba (Brown & Jones 1994).

4.2 East Caprivi

The East Caprivi is approximately 12,000 km^2 in size with a human population of about 60,000 (Erkkila & Siiskonen 1992), scattered in rural settlements and concentrated in the town of Katima Mulilo. There were originally four areas known to hold abundant wildlife: The Northern Forestry area, Mudumu N.P. area, Mamili swamps area, and the Eastern Floodplains (Fig. 3). Of these high density wildlife areas, parts of Mudumu and Mamili were proclaimed as National Parks in 1990, and the Eastern Floodplains and areas surrounding the East Caprivi national parks were

identified by the MET and IRDNC as areas of focus for community- based conservation programmes.

Figure 3: Approximate areas of the East and West Caprivi that held the highest wildlife densities between 1980 and 1990.



4.2.1 Mudumu N.P.

Mudumu N.P. (about 760 $km^{2)}$ is situated on the Kwando River, and contains mainly mixed mopane Colophospermum mopane woodlands with a lightly wooded "malapo" at its center, and floodplains with associated riparian vegetation along its river edge.

4.2.2 Mamili N.P.

Mamili N.P. (about 360 km^2) lies between the Kwando and Linyanti rivers. It makes up the largest protected wetland in Namibia and can have up to 80% of its surface area flooded in times of high floods. Most of its area consists of extended floodplains with two savanna woodland "islands".

5.0 ELEPHANT NUMBERS AND DISTRIBUTION

5.1 Introduction

The elephants of Caprivi are seasonal inhabitants of this region, and it is difficult to make a single estimate of their population size. Ideally, a wet and dry season estimate of numbers and distribution needs to be made, along with the period of time these elephants utilize the Caprivi habitat.

5.2 Dry Season

The dry season range used by elephants is their most important range, as this is the range they use for the longest period of time. It is also the range most affected by

the elephants, as this is when the elephants are most concentrated and utilizing non-perrenial vegetation such as the woodland savannah.

We estimated dry season elephant numbers and distribution in the Caprivi by conducting aerial censuses of the protected areas of Caprivi in 1993 and 1994. A detailed report of methods used, future reccomendations, results and comparisons with past surveys has been submitted to the Directorate of Environmental Affairs. This report will be published as a Modoqua article in the long term, and as a research discussion paper (Title: Wildlife Resources in the Caprivi, Namibia: The Results of an Aerial Census in 1994 in Comparison with Past Surveys) which will be made available immediately. As I do not want to repeat all this information I will only report a summary of the information here.

An aerial census of Caprivi Protected areas was carried out in the dry season of 1993 and again in 1994. As resources were limited, we had to focuss our efforts on only the protected areas as shown in figure 4. We flew the areas of greatest wildlife density with 100% coverage, and the central area of West Caprivi (where wildlife concentrations were known to be very low) with about 6% coverage. The results of the 1994 census for each of these areas is reported in Table 1

Figure 4: Map of Caprivi showing strata and actual transects flown during the 1993 and 1994 aerial census of Caprivi. Transect location shows spacing and orientation in each stratum. "High" and "Low" denote high and low sampling intensity

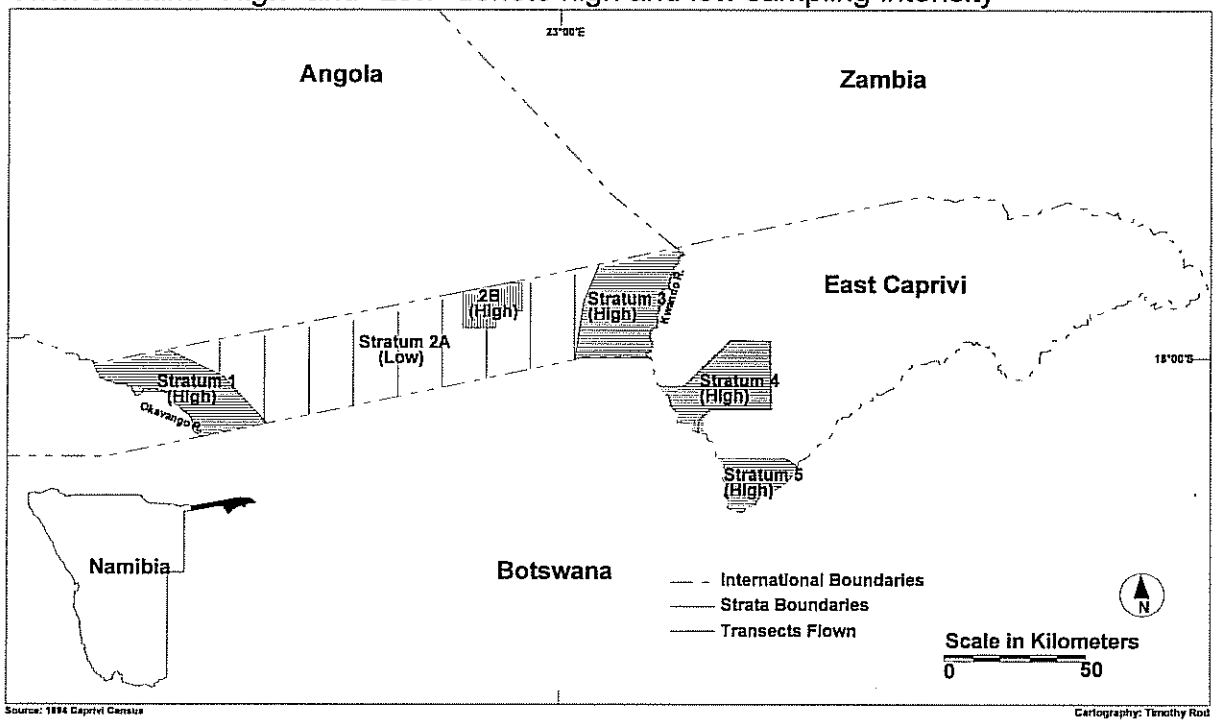


Table 1. Observed and estimated wildlife numbers from the 1994 Caprivi Census. Species are listed in order of abundance. Blank cells in the table denote the absence of that species in that stratum, or the absence of an estimate when sampled at 100% coverage. C.I. = 95% Confidence Interval. (see figure 4 for location of strata)

Species	Stratum 1 (W. Caprivi) West Core			Stratum 2 (West Caprivi, Central) Low Density (A)			High Density (B)			Stratum 3 (W.Caprivi) East Core			Stratum 4 (E.Caprivi) Mudumu N.P.			Stratum 5 (E.Caprivi) Mamili N.P.			Totals East & West Caprivi		
	No. seen	Est. (Y)	+/- C.I.	No. seen	Est. (Y)	+/- C.I.	No. seen	Est. (Y)	+/- C.I.	No. seen	Est. (Y)	+/- C.I.	No. seen	Est. (Y)	+/- C.I.	No. seen	Est. (Y)	+/- C.I.	No. seen	Est. (Y)	+/- C.I.
Elephant	1532									2953			433			638			5556		
El. Carcass	15			8	135	115	6			67			2			2			100	227	98
Buffalo	401									950			2			1173			2526		
Lechwe										38	76	89				571	1033	484	609	1109	460
Hippo.	74									220						258	472	192	552	766	179
Sable	97	187	115				1			133	265	155							231	452	150
Kudu*	23	44	28	12	213	375				126	251	92	7	12	13	17	31	31	185	551	334
Impala*							2	4	7	87	175	103	61	99	95				150	278	139
Zebra										78	156	81	61	101	145				139	257	165
Eland										94	189	251							94	189	251
Reedbuck	26	50	41							2			3	5	6	25	38	29	56	93	50
Giraffe										43	76	36							43	76	36
Roan	3	6	6							4	6	6	33	55	65				40	67	65
Tsesebe										31	28	26							31	28	26
Osterich	2			1						3	6	5							6	6	5
Settlements*	11			2			1			1									15		
Cattle	450	867	512										42	70	78				492	937	518
Goats	138	266	155	18	766	1035	16	35	60							70	128	211	242	1195	905

* Minimum estimate only because of difficulty in observing true densities from the air.

** Settlements = a collection of dwellings

Past Aerial surveys of elephant range in the Caprivi were conducted with varying intensity and consistancy due to the complicated politics of the region at that time. The results of these surveys, therefore cannot be directly compared to those conducted in 1993 and 1994, but they can be seen as a a good minimum estimate of elephant numbers for the primary elephant range in Caprivi. Figure 5 shows the location of these primary ranges in relation to the areas surveyed in 1993 and 1994.

Figure 5: Map of Caprivi showing high density wildlife areas most often censused between 1980 and 1990, compared with the strata and transects used for the 1993 and 1994 aerial census of Caprivi.

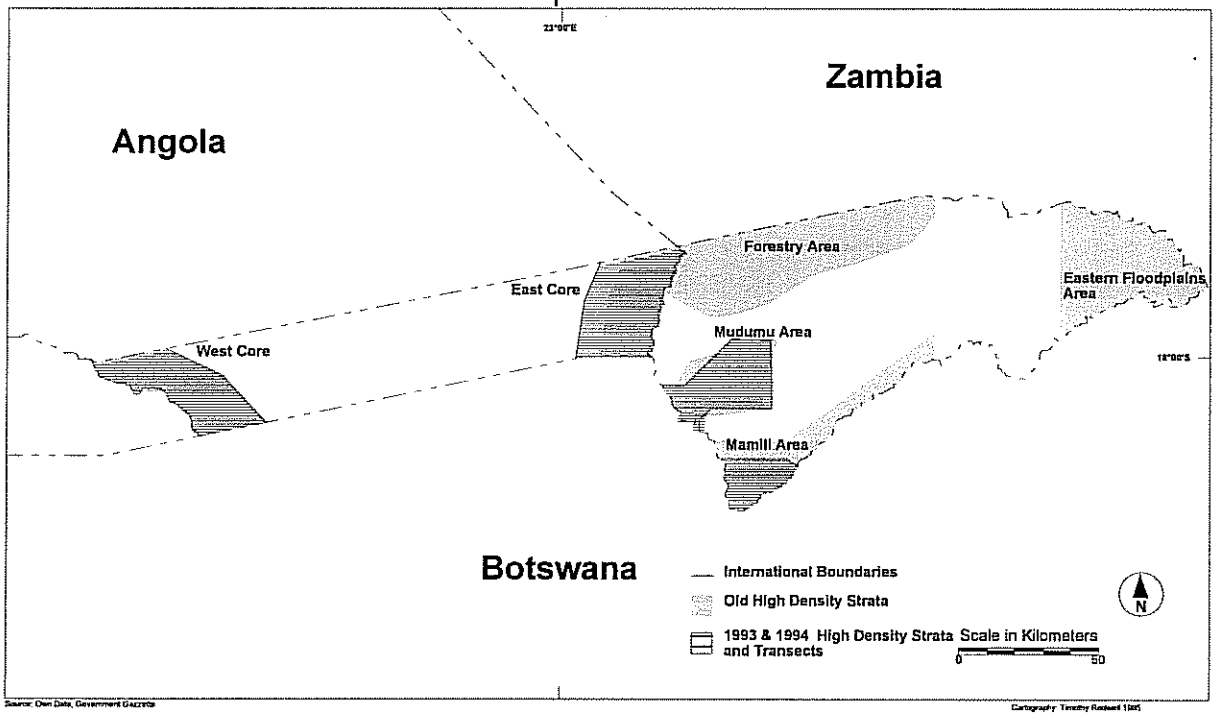


Table 2 shows the primary dry season range of large elephant populations in East Caprivi, until1988, was the Forestry area in East Caprivi. Since then, core populations of the West Caprivi, and the Mudumu area have increased considerably, and the populations in the Forestry area have decreased. The central region of West Caprivi was surveyed for the first time in 1993 and 1994., and no elephants were seen. It was therefor excluded from this table. As there were signs of elephant tracks in this region it was thought there might be very low concentrations of elephant in this area, undetected by 6% coverage of the area.

Table 2: Numbers of elephants in the primary elephant ranges of East and West Caprivi from 1980 to 1994. See Figure 5 for location of the listed areas. Blank cells denote no survey done in that area in that year. 0 = survey conducted, no elephants observed.

Area/Yr.	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1993	1994
West Core								868*			1085*	1209	1533
East Core		410*							884	728		2825	2946
Forestry Area	1509		1936	1550	1768	1353	567		1075	335			
E.Floodplains	15		0	0	41	19	157			240			
Mudumu NP	0		193	539	149	310	158		143	387	534	405	433
Mamili NP	32		135	100	57	72	136		169	189	491	187	625
Totals	1556	410	2264	2189	2015	1754	1018	868	2271	1879	2110	4626	5537

* = Only south of the road surveyed

Unfortunately we were not able to survey the Forestry Area and Eastern Floodplains in 1993 or 1994, but this area was covered by the Botswana census team in September 1994 at about 7% coverage. No significant numbers of elephants were seen by the Botswana team outside of Mudumu and Mamili N.P's in East Caprivi, and it is thought that trends seen in these areas before 1990 have probably continued to the point of their being insignificant numbers of elephants outside of the protected areas of East Caprivi. Numerous elephant problems are reported by subsistance farmers in the Eastern Floodplains area, but these crop raiders usually only move temporarily into Namibia in the night, and return to Botswana before daybreak (C.O'Connell unpublished). There is no other evidence that there are significant numbers of elephants that use either the Foresry area or Eastern Floodplains on a permanent basis. Preliminary data from the ELESMAP census of 1995 of all East Caprivi also supports this observation.

5.3 Wet Season

A low intensity wet season census of the entire Caprivi was planned for March 1995, to try and estimate the numbers and distribution of elephants during this season. Unfortunately this census had to be cancelled because of unusually low rainfall which made that season unrepresentative.

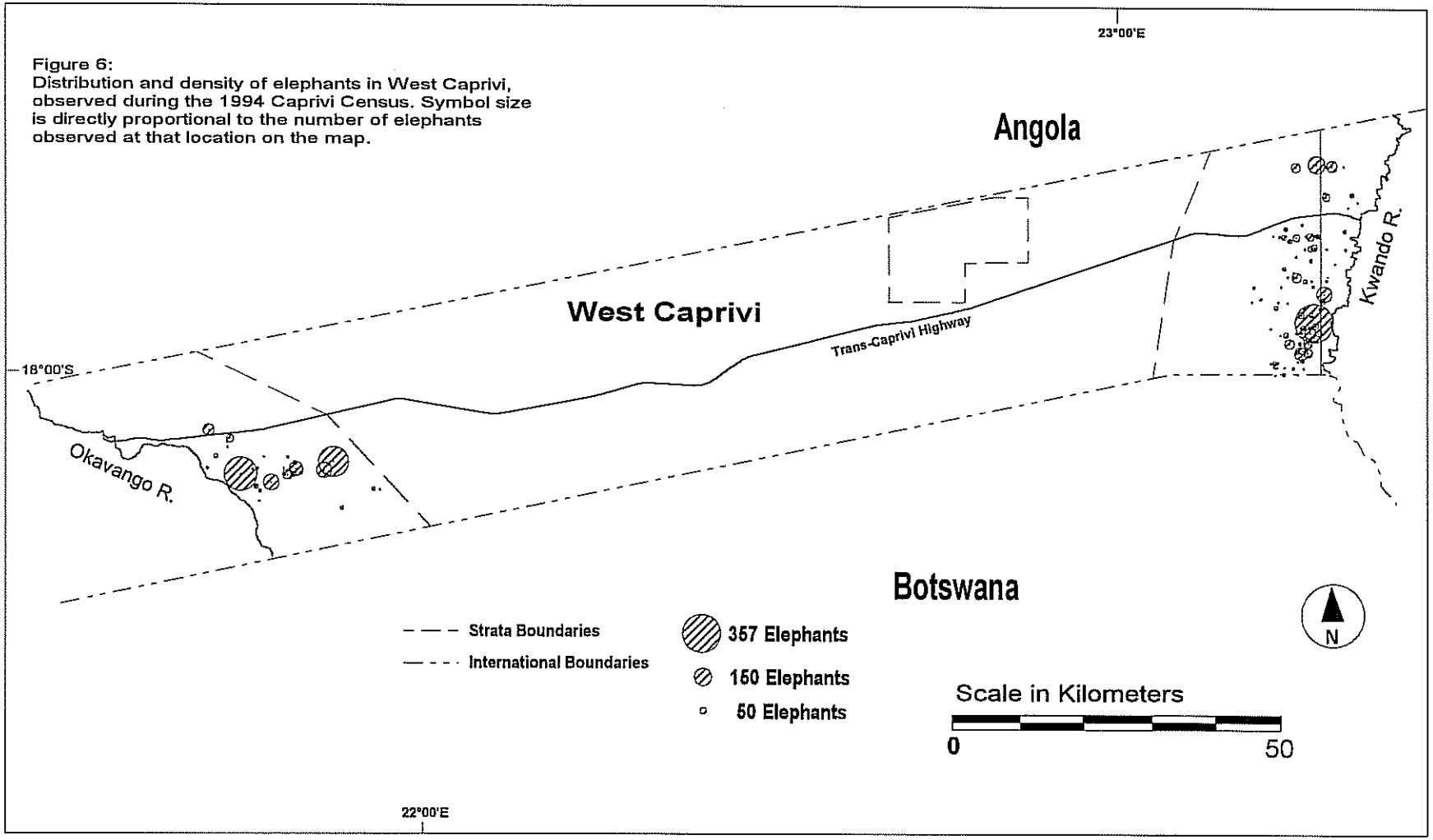
Satellite tracking of elephants that were resident in Caprivi during the dry season, has shown that many dry season elephants move out of the Caprivi for part of the wet season, but there is presently no accurate information available to estimate how many elephants move into Caprivi for the wet season. Ground based Community Game Guards working with IRDNC in the central region of West Caprivi (which holds very small or no elephant populations in the dry season), have made numerous reports of large herds of elephant in this region during the wet season. As none of the satellite collared elephants moved into this region during the whole time they were tracked, it is probable that the elephants observed in the wet season in Central West Caprivi, come from Botswana, due south. If this is the case, it would be usefull to conduct a wet season survey to determine how the numbers and distributions of elephants change between seasons. It is possible that influx and outflow of elephants is almost equal, and that a fairly stable total number of elephants utilize Caprivi habitats year round.

5.4 Conclusions

It would seem from the 1993 and 1994 census of Caprivi that there are approximately 4000 - 5,500 elephants using Caprivi for their dry season range. Census results and other evidence indicates that these elephants are all concentrated in the core protected areas of East and West Caprivi at present, and can all be found within 30 km of the river frontage strips of these protected areas (Figures 6 & 7).

There is most likely a different number and distribution of elephants utilizing Caprivi habitats during the wet season, but this project was unable to assess the extent of this difference with the cancellation of the 1995 wet season census. It is important that this census be executed during the next wet season to complete the picture of seasonal variation of numbers and distribution of elephants in Caprivi.

Figure 6:
Distribution and density of elephants in West Caprivi, observed during the 1994 Caprivi Census. Symbol size is directly proportional to the number of elephants observed at that location on the map.



Source: 1994 Caprivi Census

Cartography: Timothy Rodwell 1995

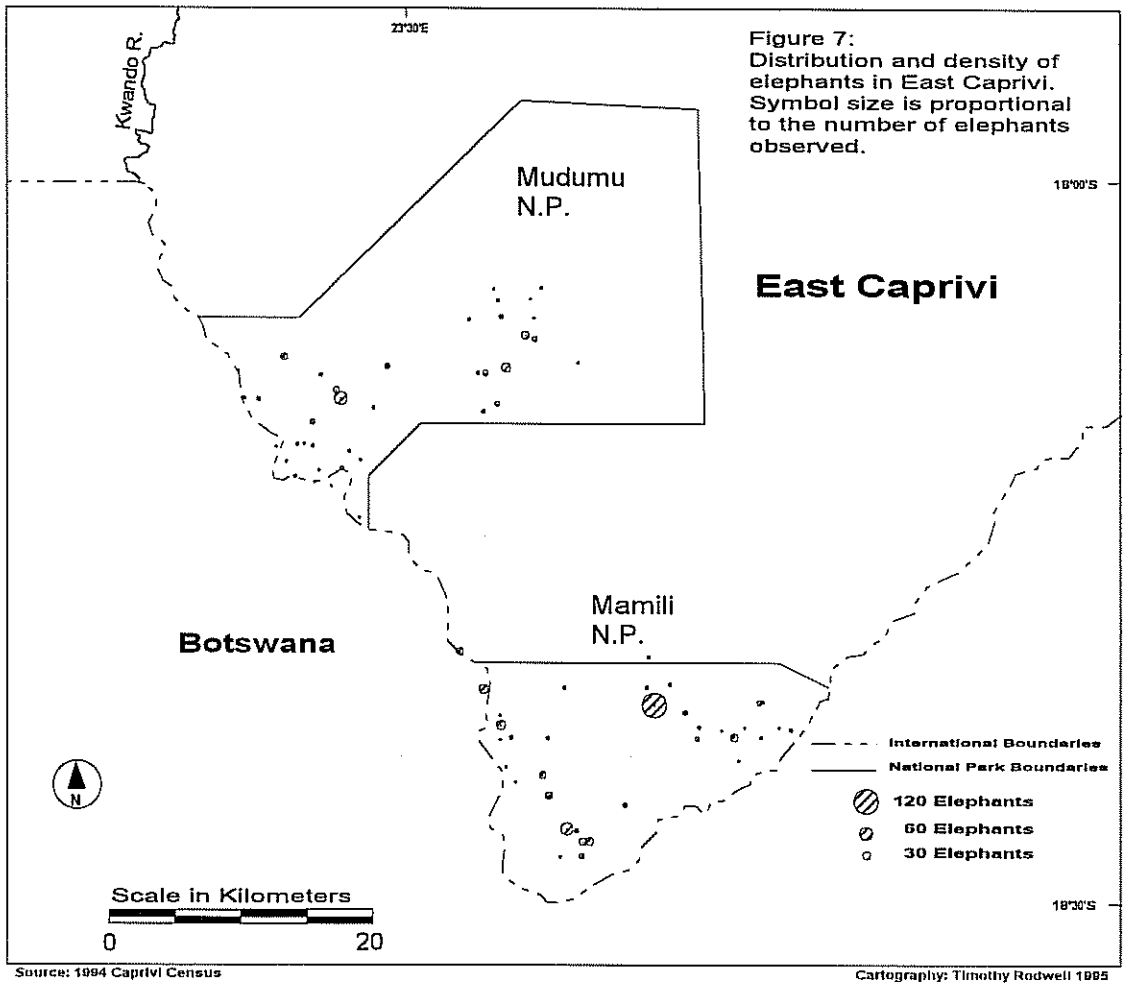


Figure 7:
Distribution and density of elephants in East Caprivi. Symbol size is proportional to the number of elephants observed.

6.0 SATELLITE TRACKING and MOVEMENTS

Traditionally, the movements of animals have been tracked and recorded using VHF telemetry either based on the land or used from an aeroplane. To follow the movements of elephants in the Caprivi this method of tracking was not practical due to the cross-border movements of the animals, and the logistic problems of getting aircraft time in the Caprivi where such resources are scarce.

The solution to this problem was to use a combination of satellite and VHF telemetry based on a collar put around the neck of an elephant. Unfortunately, the cost of this type of tracking is high, and only ten such collars were available for this project. Eight of these collars were put on adult female elephants to track the movement of eight family herds (± 10 elephants in a herd), and one collar was put on an adult bull elephant in Mahango Game Reserve to try and get an indication of Mahango bull movements. The tenth collar was used as an error correction beacon at a stationary location in the Caprivi.

At minimum we were therefore tracking about 80-90 elephants with satellite collars from August 1993 till about May 1995 (three dry seasons and two wet seasons). The dry season elephant population of Caprivi is estimated at about 5000 elephants, which makes the sample size of the elephants tracked, under 2% of the total population. As the tracking sample size is so small, it is difficult to say how representative the observed movements are, of the whole Caprivi elephant population, when looked at in isolation. However, other observations, extensive census work in both Caprivi and Northern Botswana, as well as years of elephant tracking (both VHF and satellite) in Botswana, support many of the findings of this project, and I am confident the observed movements represent the probable movements of a good proportion of the Caprivi elephant population at the present time. I stress "at the present time" as it seems from this study and others like it, that elephants most likely use their ability to cover vast distances very efficiently, to cope with any changes and stresses in their environment. It is therefore likely, that any major changes in present elephant environment in Caprivi or Botswana, will result in variations in the general patterns observed during this study

6.1 Satellite Tracking

6.1.1 Introduction

Transmitters in the satellite collars sent signals once every week for a 24 hr. period. These signals were received by the NOAA series of satellites, and transmitted back to the Etosha Ecological institute in Etosha N.P. where they were received by a Local User Terminal (LUT). This LUT then used the signals to calculate the locations of the transmitting elephants. Due to the nature of the Satellite transmitters and the location calculation system, all satellite derived locations were expected to deviate from the true location of the elephant. In order to use these locations, this location error had to be estimated for each set of calculated satellite locations.

6.1.2 Error Estimation and Ground Truthing

One of the satellite transmitters not placed on an elephant, was put in a known stationary location in the Caprivi to act as a correction beacon. As the true location of this of this beacon was known, it was possible to calculate the distance between the satellite derived location and the true location of the beacon. This error is the straight line error (SLE) of the location, and it was assumed that SLE in the beacon would be representative of the SLE in the elephant locations (although it was expected to be slightly different due to the absorbing mass of the elephant which distorts the transmission slightly). In order to ensure this assumption was accurate, we used the VHF transmitters (also on the collars) to track the elephants on the ground and get their true position while the satellite transmitters were transmitting. The SLE between the elephant's true position, and the satellite calculated location could then be compared to the SLE in the correction beacon, for the same satellite pass, and a relationaship between the two calculated.

The difficulty in finding the elephants at the right time of a successful satellite pass was underestimated, and I never managed to complete as many of these ground truthing experiments as I would have liked. Table 3 lists the observed SLE in eight ground truthed satellite locations of elephants, relative to observed SLE's in the correction beacon. The SLE's in the corrected elephant locations, and those in the correction beacon are positively correlated ($p=0.05$, $r^2=0.972$), but the relationship between the two SLE's still need to be determined if I want to use the correction beacon to calculate the exact SLE in all the elephant locations. For the puposes of the primary analysis of this work, I only used the beacon SLE as an indication of when a set of satellite locations had an SLE of greater than 5 km.

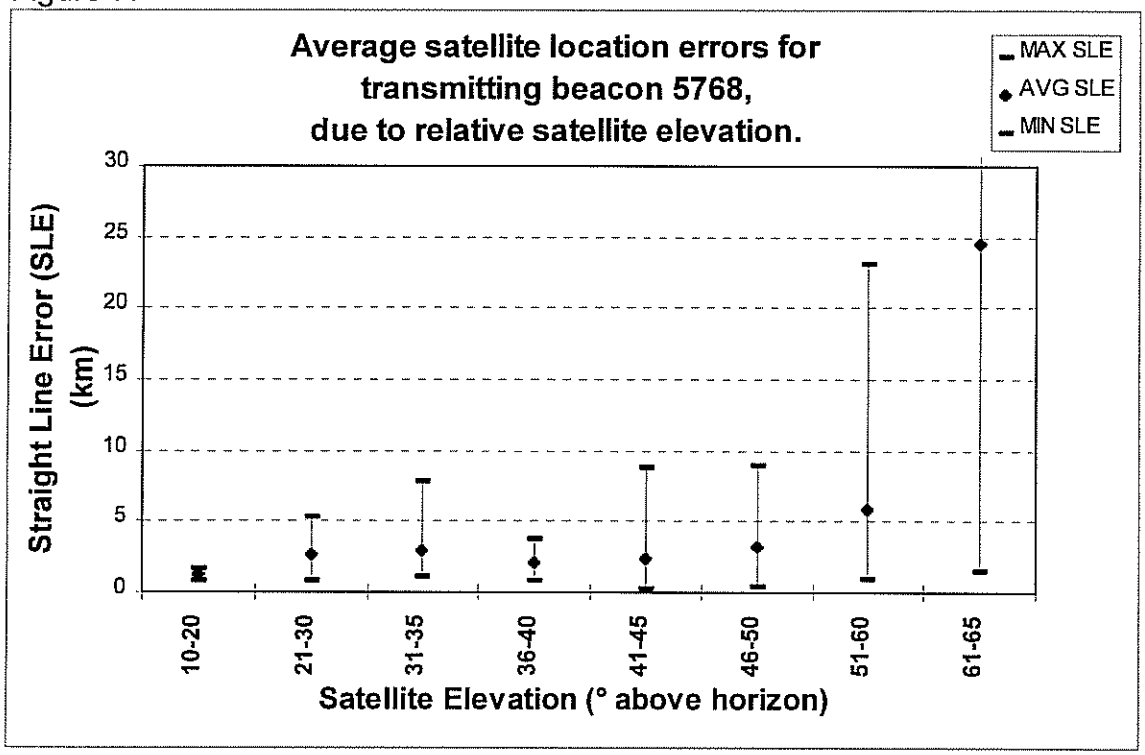
Table 3: Straight Line Errors (SLE) in satellite locations of elephants and the correction beacon: 5768

Elephant ID	Date	Satellite Elevation (°)	Elephant SLE (km)	5768 SLE (km)	SLE Difference (km)
5769	21/11/93	72	3.06		
5767	17/4/94	38	5.26	2.77	2.49
5767	17/4/94	64	22.68	28.94	6.26
5767	17/4/94	60	6.94	3.2	3.74
5767	18/4/94	59	1.14	1.50	0.36
5760	25/4/94	43	5.21	1.60	3.61
5767	1/6/94	30	3.89	0.99	2.9
5763	5/6/94	45	1.45	1.19	0.26

It became evident in the early stages of the analysis of satellite location error, that the variable most affecting SLE in the correction beacon (and therefore in the elephant locations also), was the elevation of the receiving satellite, relative to the location of the satellite transmitter. Figure 7 shows how the average SLE increases exponentially with satellite elevation over a certain value. It is also evident from table 3, that not only is the SLE greatest at elevations over 60° , but also that the

difference between known elephant and correction beacon SLE, is greatest at satellite elevations over 60°. Based on this evidence, we tried to avoid collecting satellite data from satellites with an elevation of over 60° (relative to the satellite transmitter).

Figure 7:



6.1.3 Analysis of Satellite Derived Location Data

For the final analysis of satellite derived locations and home range calculation of the tracked elephants, I removed all sets of locations for which the SLE on the correction beacon was greater than 5 km, or for which the satellite elevation relative to the transmitters was over 60°. The remaining locations can then all be considered to have a maximum location error of ±5 km. Table 4 indicates the overall performance of the satellite transmitters and overall numbers of locations that could be used for each tracked elephant (ie locations with SLE's less than 5 km).

Table 4: Summary of satellite collar performance for each satellite transmitter.

Elephant ID No.	Where Collared	Total # Satellite Locations	Total # Satellite Locations Used	# Weeks Monitored	Avg Collar Performance (Locats./Week)
5760	Mahango G.R.	22	19	67	0.3
5761	W.Caprivi	21	19	57	0.3
5762	W.Caprivi	188	149	84	1.8
5765	W.Caprivi	255	130	51	2.5
5766	W.Caprivi	137	114	79	1.4
5767	W.Caprivi	204	59	39	1.5
5769	W.Caprivi	92	73	66	1.1
5763	Mudumu N.P.	112	84	81	1.0
5764	Mamili N.P.	46	36	80	0.5
5768	Error Beacon	142	127	31	4.1

Avgs.		122	81	64	1.5
S.E.		26.38	15.91	6.20	0.39

From all the satellite transmissions received, an average of 122 (SE=26.4, n=9) locations were calculated for each collared elephant. An average of approximately 66% of the locations for each elephant were estimated to be accurate to within 5 km, and used for the purposes of movement and home range analysis.

6.2 Movements and Home Ranges

6.2.1 Introduction

Nine elephants were fitted with satellite/VHF telemetry collars in August 1993. These collars were fitted on randomly chosen individuals along the Kavango and Kwando Rivers, and in Mudumu and Mamili N.P.'s. The movements of these elephants was monitored between 10 and 20 months, depending on the satellite transmitter performance and what happened to the elephant over the course of the study.

Of the nine elephants monitored , one was shot in Botswana by nature conservation officials as a possible problem animal (see Appendix 1), and one was poached just south of the Angola border about 15 km west of the Kwando River. The seven remaining elephants (excluding one whose VHF transmitter malfunctioned) were re-located in July 1995, and had their collars removed, after carrying them for about 23 months.

6.2.2 Results and Discussion

Figures 8 -16 show the minimum home ranges (calculated using Minimum Convex Polygons) of each of the collared elephants, as well as the locations where they were originally collared in August 1993, and where their collars were removed. almost exactly two years later. These figures also show the satellite locations that were received in the dry (May to October) and wet (November to April) seasons, to indicate the variation in habitat use patterns in the different seasons.

Figures 8-16 indicate that the elephants found in the Caprivi during the dry season are generally seasonal inhabitants of these regions. The overall picture of these movements is, however, far more complex than I assumed from primliminary analysis of satellite locations. Over the course of three dry seasons and two wet seasons, three general patterns of movement became apparant:

1) All season use of Caprivi habitat with little or no range outside of Caprivi.

2) All season use of Caprivi with extensive range outside of Caprivi in the wet season only.

3) All season use of Caprivi with extensive wet and dry season range outside of Caprivi.

1) Pattern one (Figure 8 and Figure 10) is probably the least common of the three patterns in the elephant populations outside of Mahango G.R., but it is difficult to say how common it is in the Mahango G.R. The Mahango G.R. is thought to hold only bull elephants with few or no breeding herds ever observed. The origins of this

"population" of bulls is largely unknown, and it is therefore very difficult to even guess at their probable movement instincts. From other observation during census work in that area, and observations of land use in Botswana, I would imagine there are not many options still open for movement to these elephants with human settlements and limited water supplies north, south and west of Mahango. The elephant in Figure 8 was relocated literally meters away from the exact position that we oginally collared it two years previously. Although this could represent an anomoly we happened to collar, the regular sighting of recognizable individuals in Mahango G.R., suggests this elephant's movements might be indicitive of more than just an anaomoly.

Outside, of Mahango G.R., pattern one (Figure 10) seems uncommon, with only one of the eight remaining collared elephants exhibiting this behaviour. It is interesting that this elephant also had the only significant (ie. greater than 5 km) movement into Angola, relatiive to the other collared elephants that used the "Kwando Core" range. Without reading too much into this, it is interesting to wonder if this indicates that this particular family of elephants has had an ancestral wet season range in Angola that it can no longer use as result of human pressure there

2) Pattern two (Figures 9,11,12,14 & 15) seems to be the most common pattern of movement exhibited. Even if one excludes elephant 5761, (Figure 9) (as it was only tracked for a little over a year before its trnsmitter failed) almost half of the elephants collared, only used dry season ranges within Caprivi, but made use of other ranges outside of Caprivi for part of the wet season. As I only received on average 1-2 satellite locations for a 24 hr period once a week, it is possible the elephants were outside of Caprivi in the dry season on occassions, but it is improbable that this occured reguarly, and was not observed in two years of tracking. One of the most interesting of these movements was the north movement of the elephant herd from Mudumu N.P. This movement takes the elephants through densley settled areas and over a major tarred road to reach range approximately in the Sioma Ngwezi N.P. in Zambia.

The time this herd spent in Zambia was only a matter of weeks in the first year it was monitored, and even less time in the second year it was monitored. This indicates a possible social connection with elephant herds in Zambia, that the Mudumu N.P. elephants are reluctant to give up despite the pressures of reaching Zambia. I would predict that this movement will eventually be abandoned, and perhaps movement south into Botswana will be substituted. It is unlikely that this observed movement from Mudumu N.P. represents the tendency for the whole dry season population of Mudumu NP to move north for part of the wet season, but elephant tracks heading north over the tarred main road during the wet season, suggest more than just one herd of elephants is using this route north.

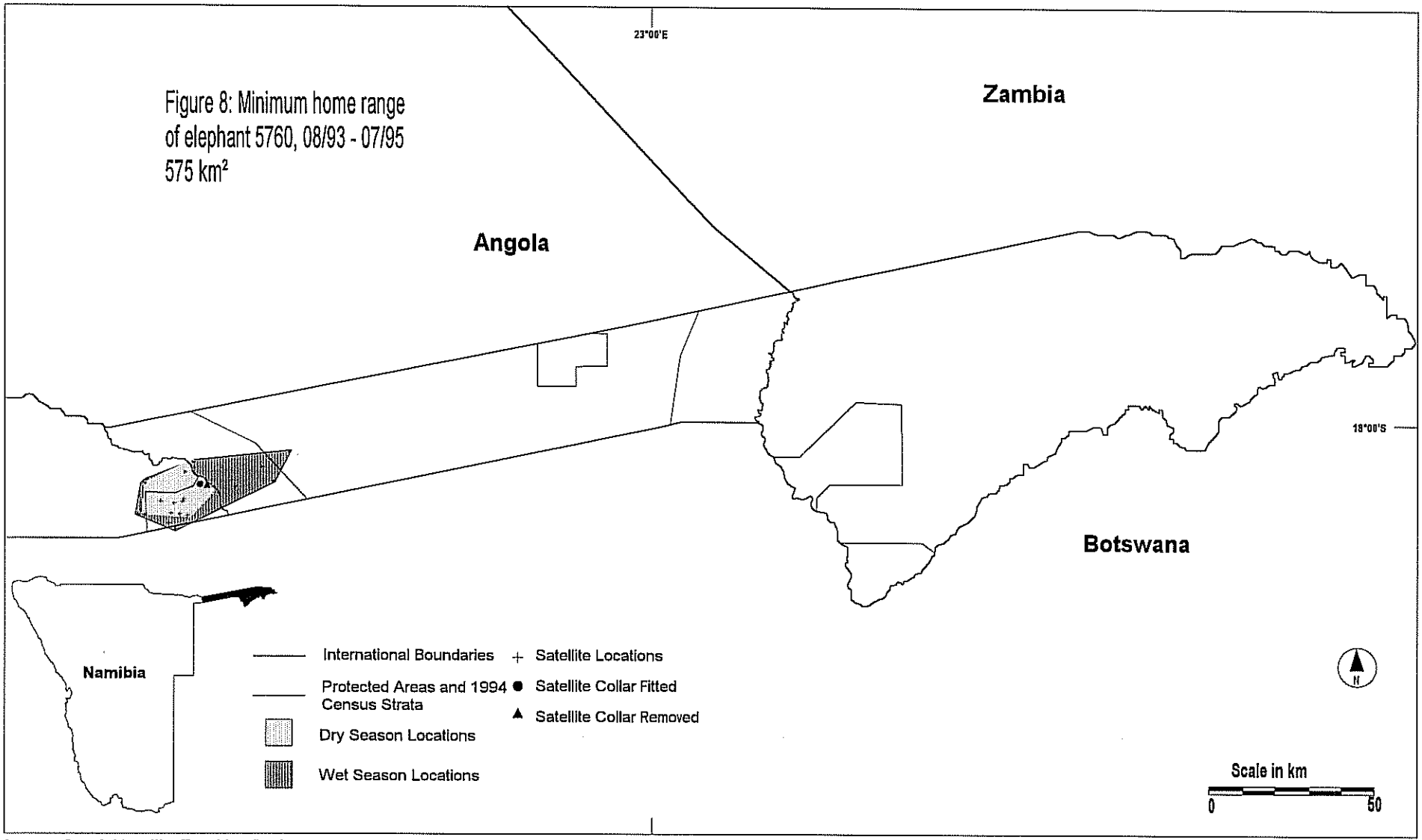


Figure 8: Minimum home range of elephant 5760, 08/93 - 07/95 575 km²

Source: Caprivi Satellite Tracking Project

Cartography: Timothy Rodwell 1995

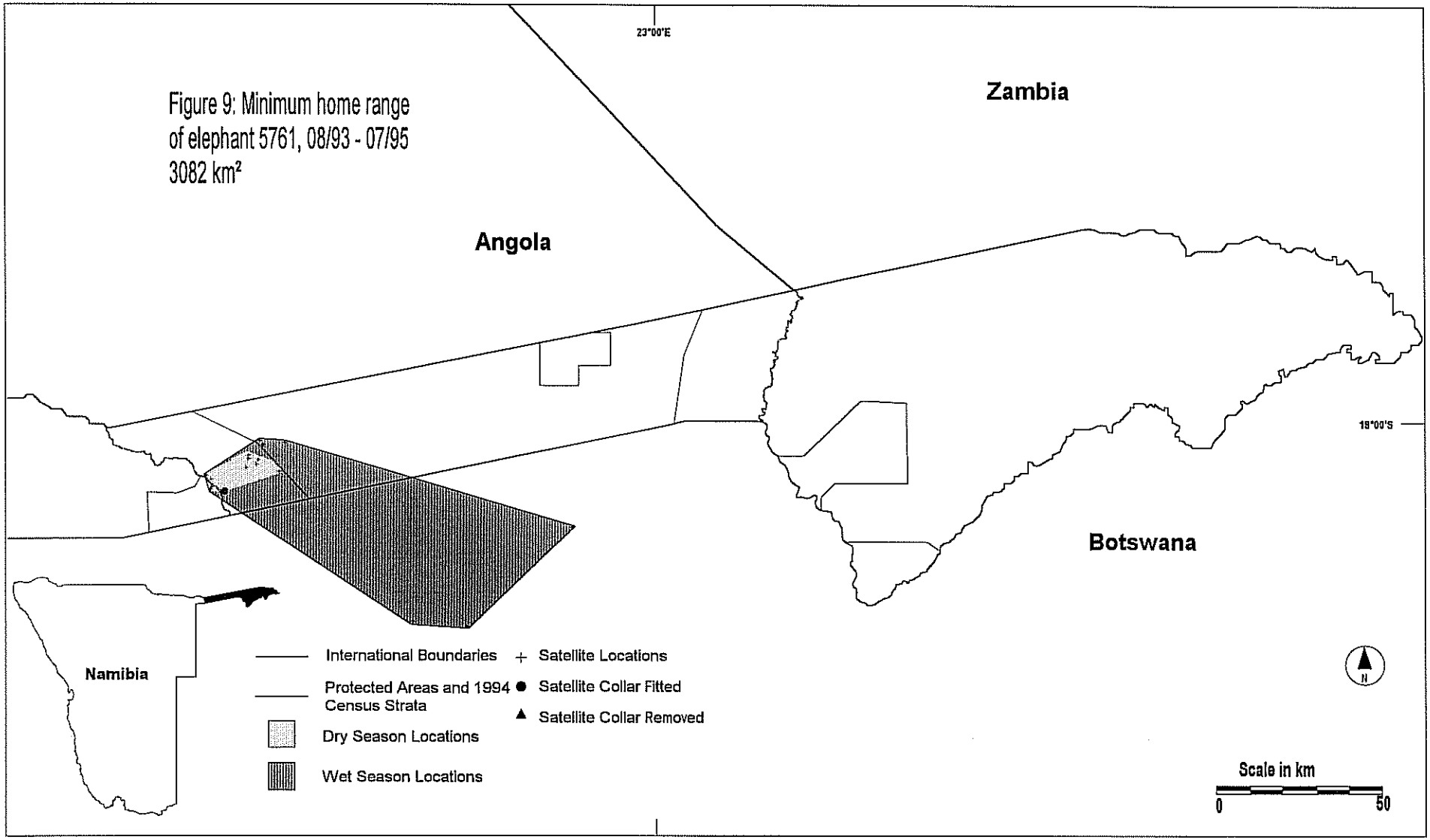


Figure 9: Minimum home range of elephant 5761, 08/93 - 07/95 3082 km²

Source: Caprivi Satellite Tracking Project

Cartography: Timothy Rodwell 1995

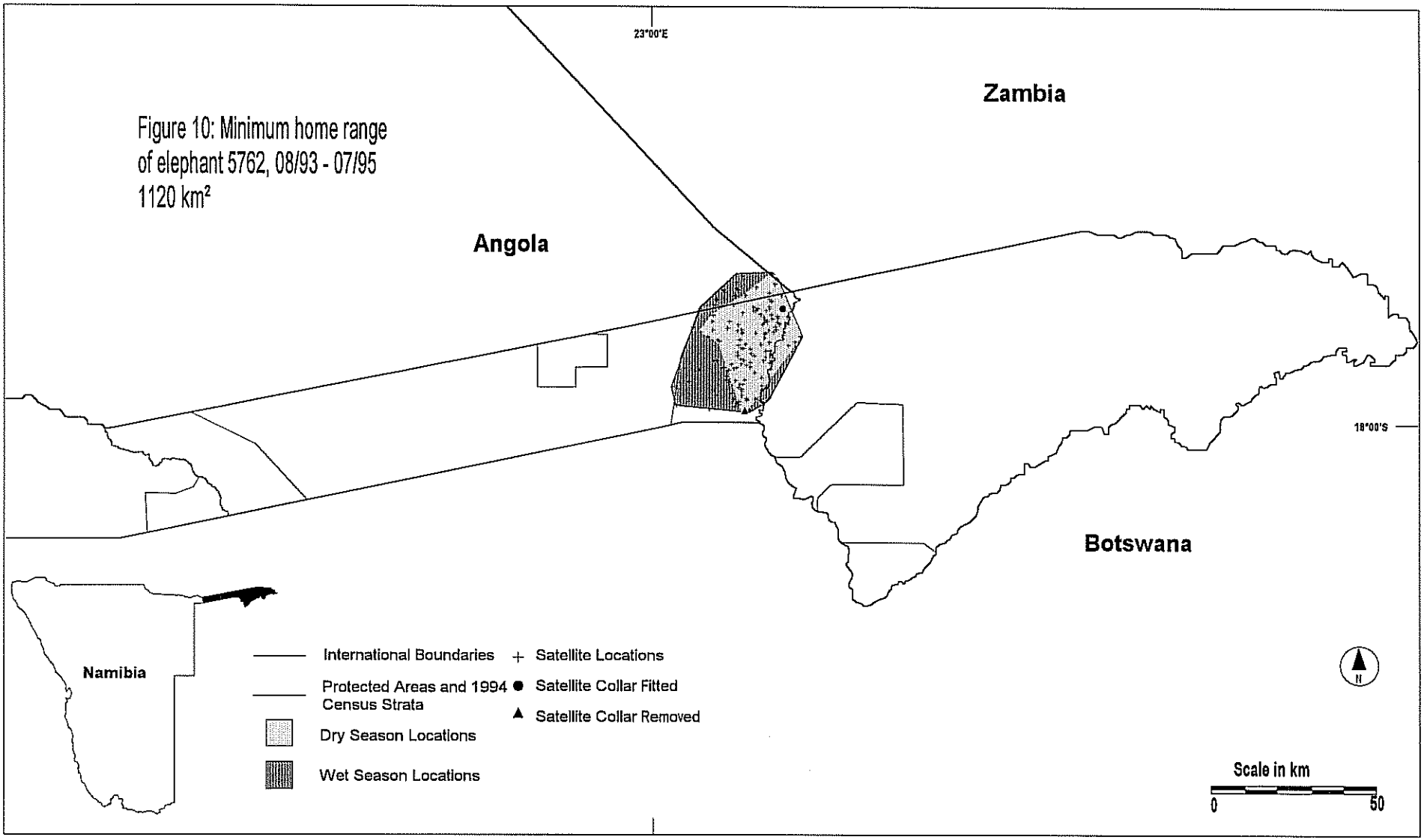


Figure 10: Minimum home range of elephant 5762, 08/93 - 07/95
1120 km²

Source: Caprivi Satellite Tracking Project

Cartography: Timothy Rodwell 1995

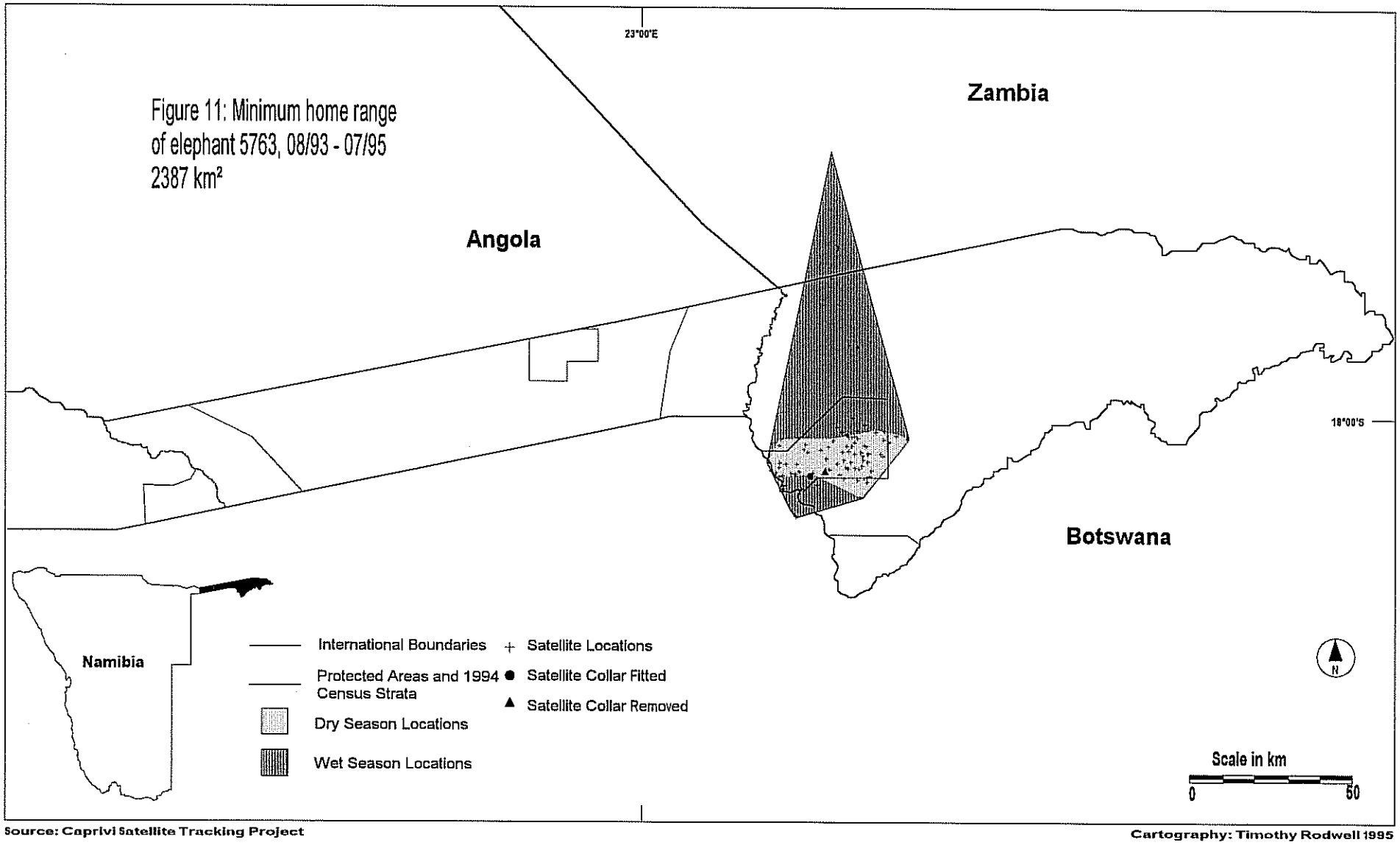


Figure 11: Minimum home range of elephant 5763, 08/93 - 07/95 2387 km²

Source: Caprivi Satellite Tracking Project

Cartography: Timothy Rodwell 1995

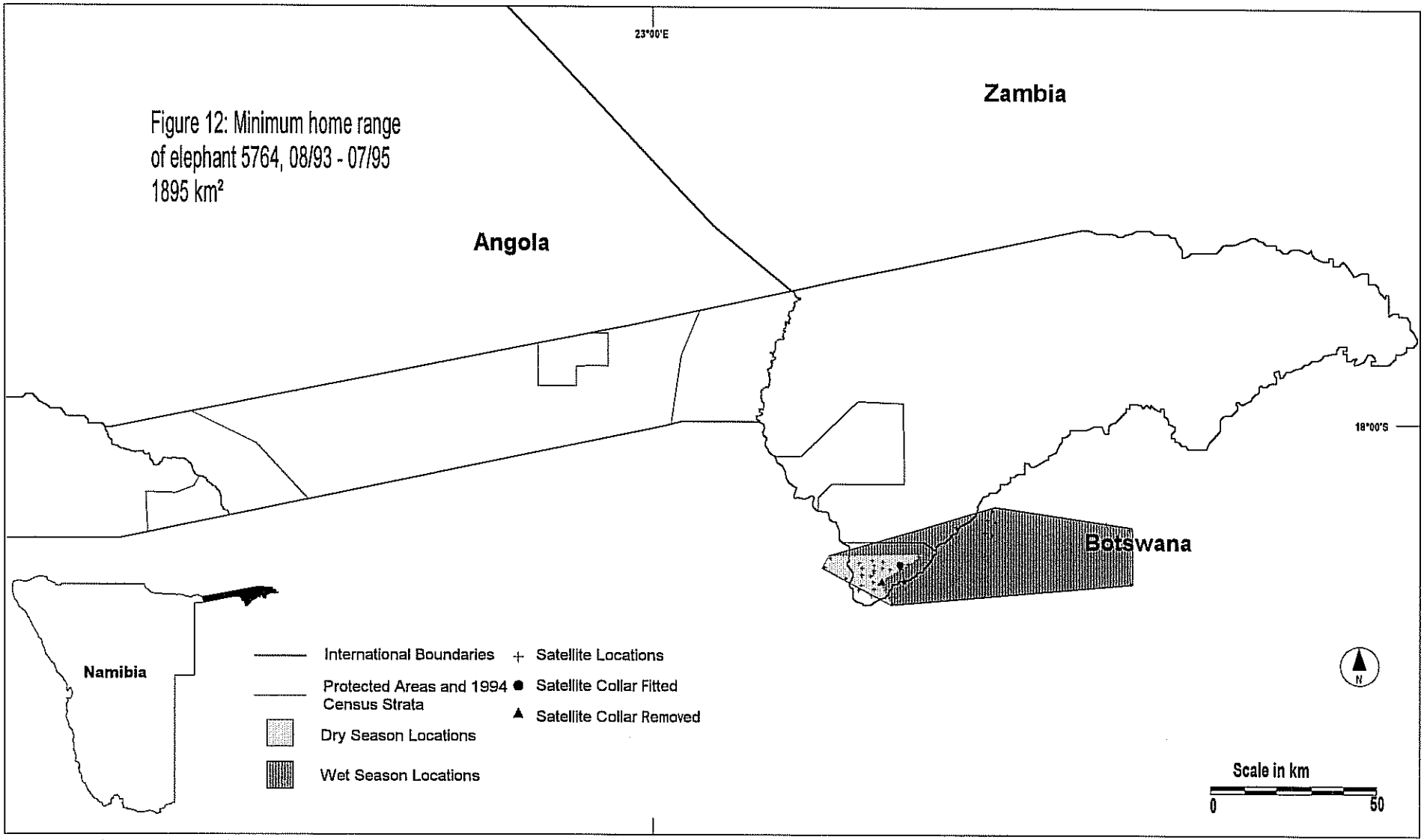


Figure 12: Minimum home range of elephant 5764, 08/93 - 07/95 1895 km²

Source: Caprivi Satellite Tracking Project

Cartography: Timothy Rodwell 1995

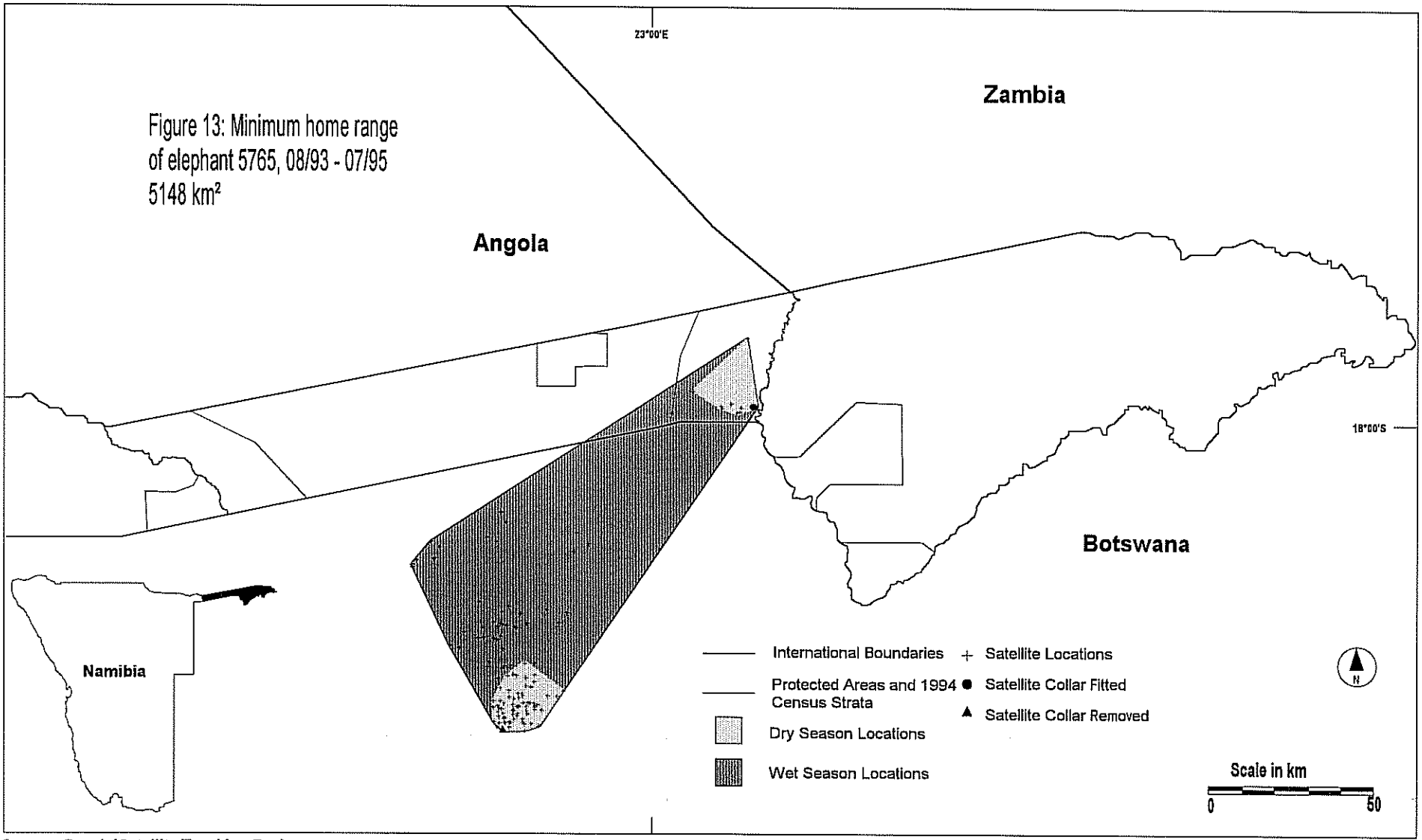


Figure 13: Minimum home range of elephant 5765, 08/93 - 07/95
5148 km²

Source: Caprivi Satellite Tracking Project

Cartography: Timothy Rodwell 1995

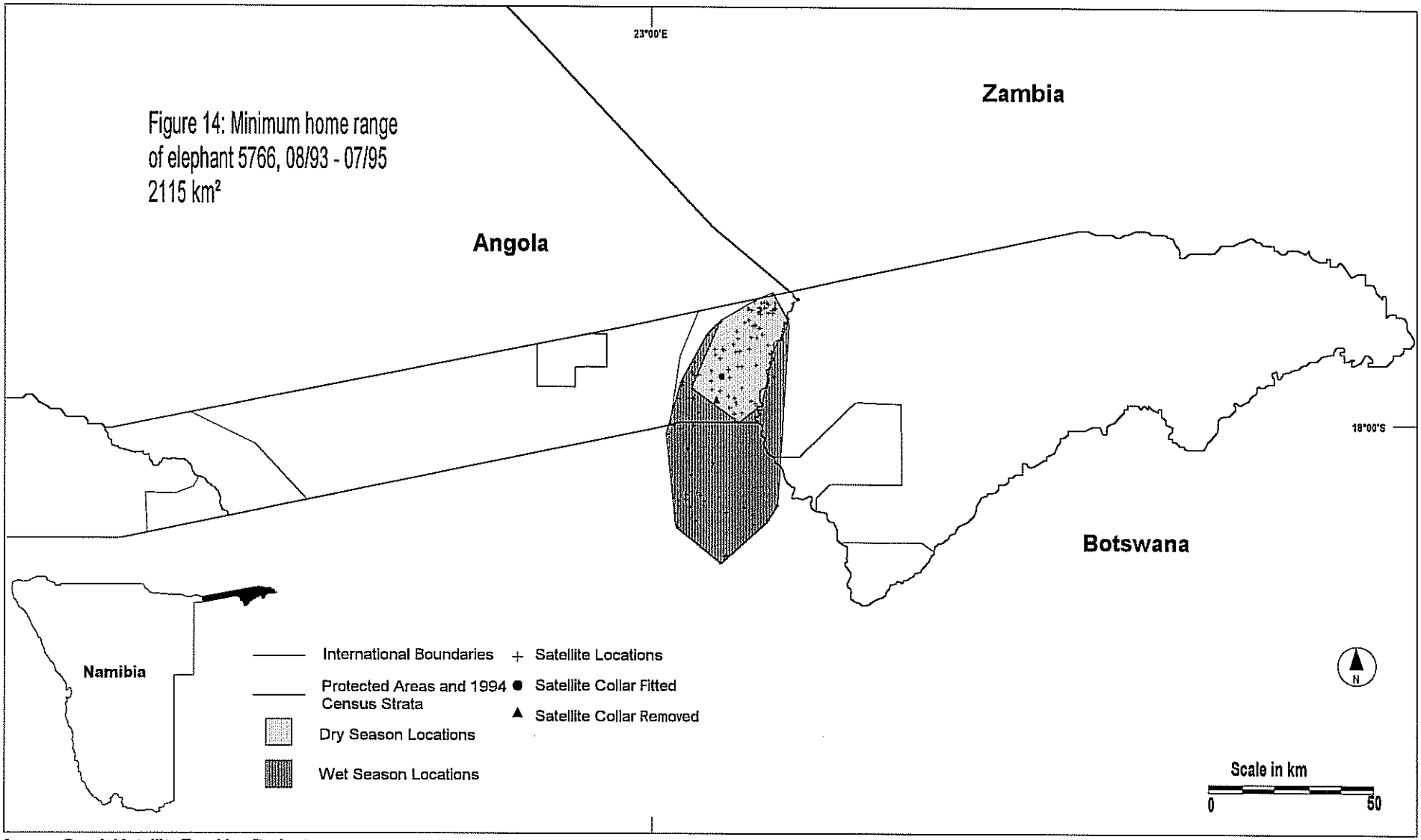


Figure 14: Minimum home range of elephant 5766, 08/93 - 07/95 2115 km²

Source: Caprivi Satellite Tracking Project

Cartography: Timothy Rodwell 1995

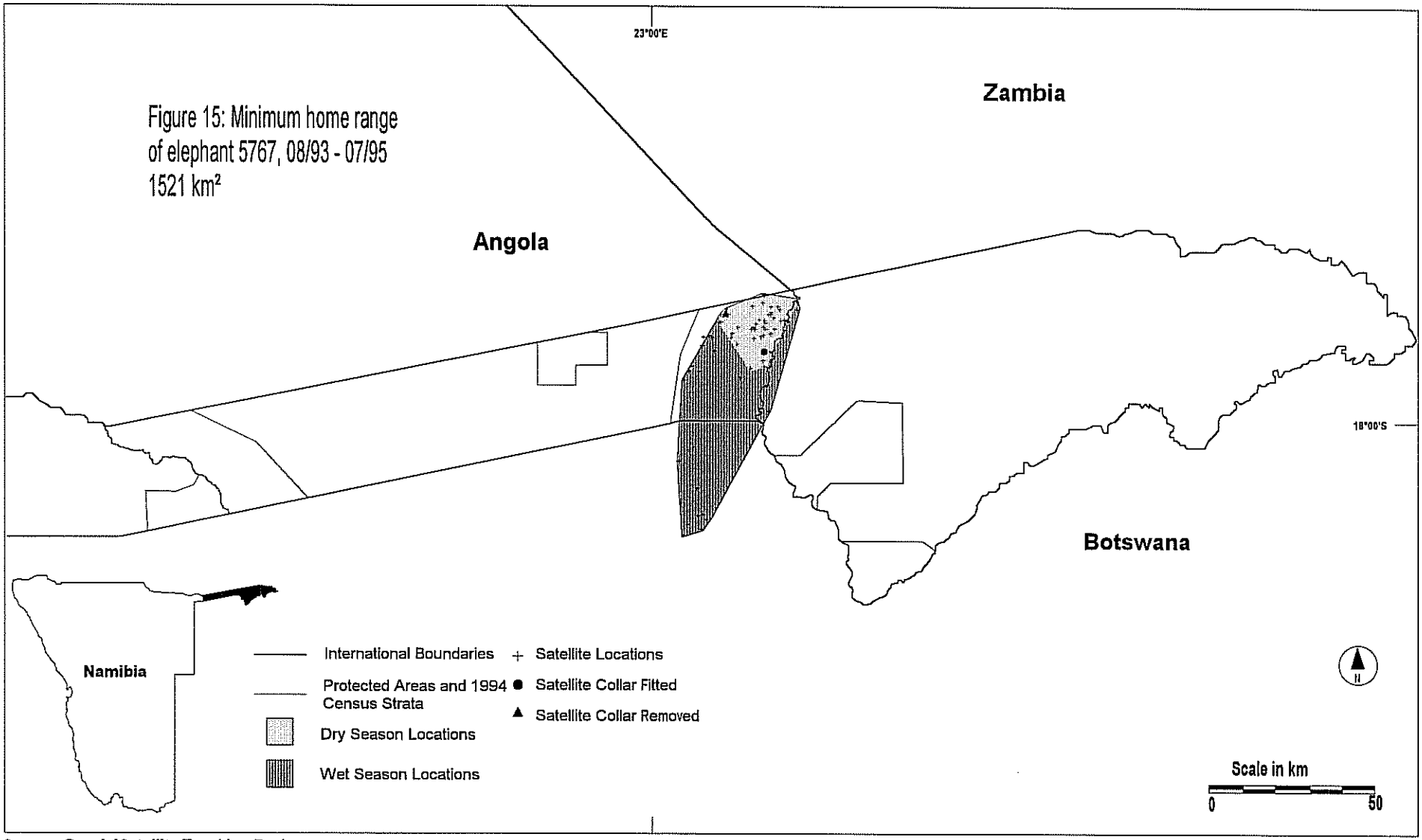


Figure 15: Minimum home range of elephant 5767, 08/93 - 07/95
1521 km²

Source: Caprivi Satellite Tracking Project

Cartography: Timothy Rodwell 1995

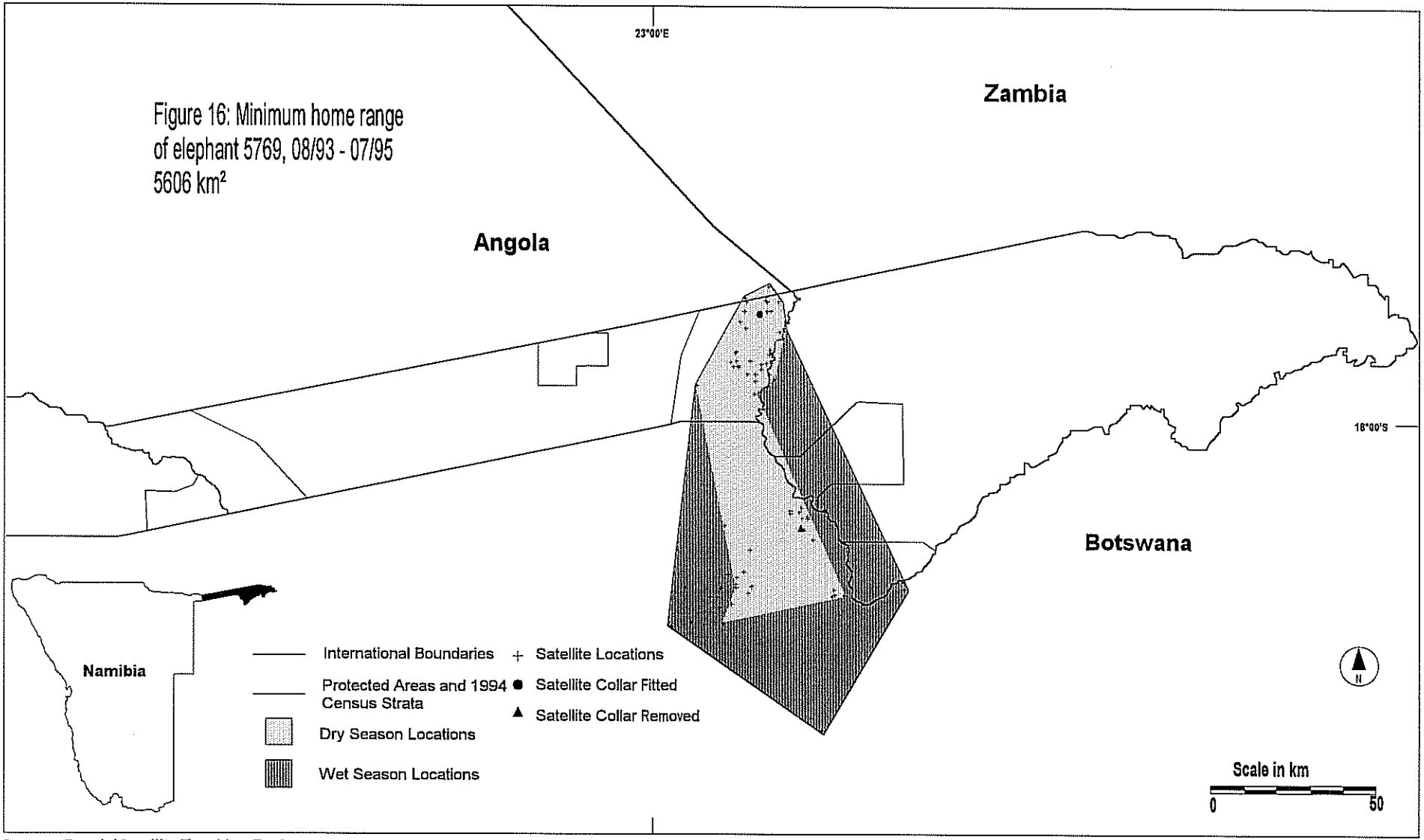


Figure 16: Minimum home range of elephant 5769, 08/93 - 07/95
5606 km²

Source: Caprivi Satellite Tracking Project

Cartography: Timothy Rodwell 1995

3) Movement pattern 3 indicates the presence of elephants in the Capriv population that use both Caprivi and Botswana for a wet and dry season range, probably only moving from one to the other if local conditions are not suitable. Unfortunately elephant 5765 (Figure 13) was shot only one year into the study, as it would have been usefull to observe if this elephant would have returned to Caprivi eventually.

Figure 17 is a compiliation of the individual home ranges observed for each elephant. This figure was constructed by simply joining all of the outermost satellite locations for the wet and dry seasons, and represents an estimate of minimum range utilized by all the collared elephants from August 1993 to May 1995. Ground and aerial census observations support the general structure that the satellite derived ranges show. It is important to note that all tracked elephant range within the Caprivi (wet or dry season) is primarrly within the core protected areas of Caprivi, within about 30 km of the rivers. Depending on how representative these tracked movements are, this means that whenever elephants are in the Caprivi they are utilising a very small habitat, and possibly putting a great feeding pressure on these areas.

None of the elephants tracked during this project made any use of the cental region of West Caprivi. Due to the almost complete lack of water in this central region, almost no elephants are seen here during the dry season, but a few hundred (and possibly more) elephants are seen here in the wet season, by reliable community game guards based in this region. It is probable that the elephants seen in the wet season here, are coming up from Botswana and returning again in the dry season. This observation is supported by similar observations of elephant distributions seen in wet and dry season aerial surveys of Botswana. When interpreting these ranges ,one should keep in mind that mostly cow elephant herds were tracked, and that bull elephants possibly do not have ranges so restricted to core protected areas. This is important to find out, however, as if the ranges shown here are accurate for bull and cow elephants alike, this may have negative implications for the hunting of elephants outside protected areas.

Table 5 lists the minimum home ranges of the nine satellite collared elephants, as well as the approximate amount of the time each elephant spent outside of Caprivi while monitored. The home ranges were calculated using minimum convex polygons (M.C.P.) using all of the satellite locations (100% M.C.P.) with SLE's of less than 5 km.

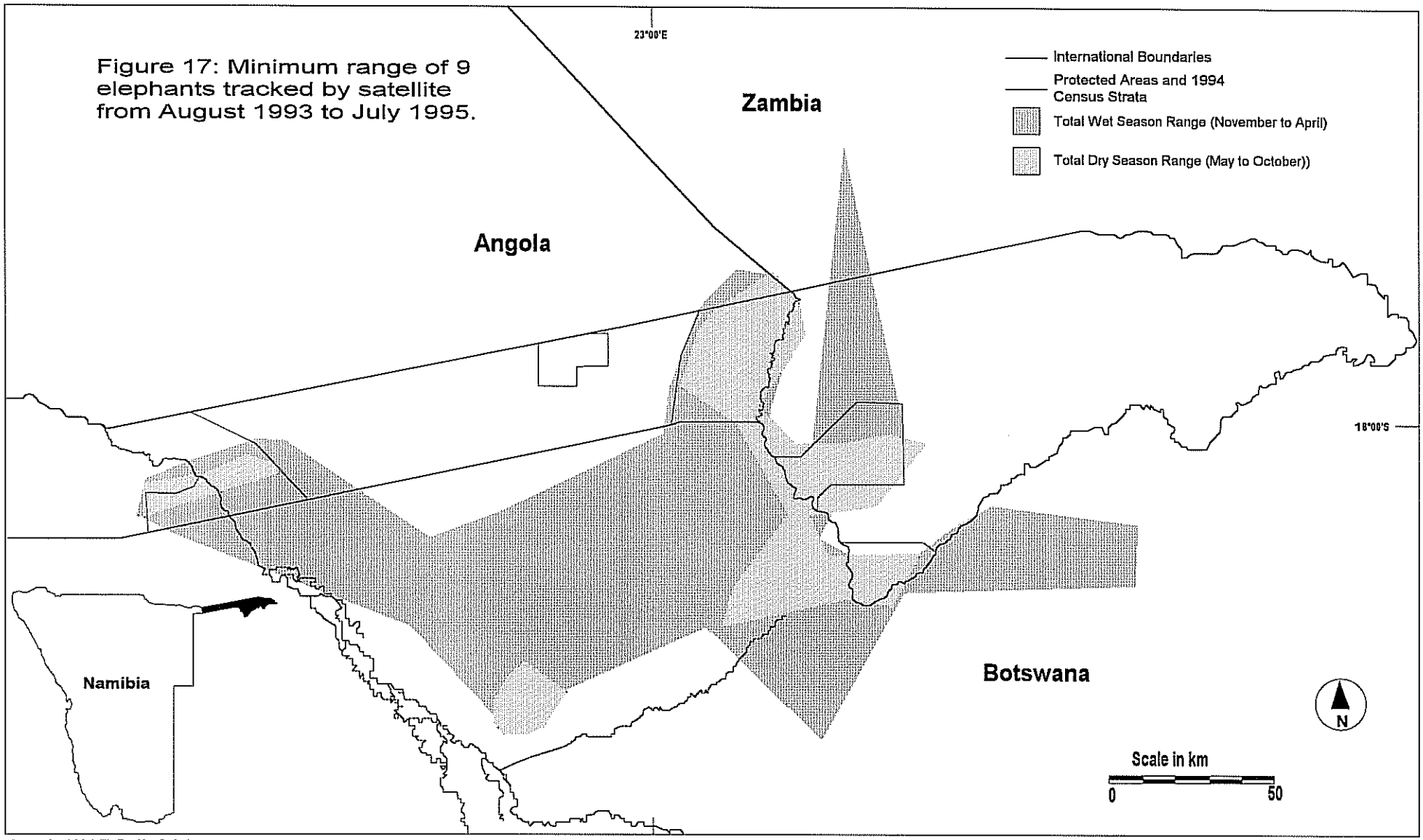


Figure 17: Minimum range of 9 elephants tracked by satellite from August 1993 to July 1995.
23°00'E
Zambia
Angola
International Boundaries
Protected Areas and 1994 Census Strata
Total Wet Season Range (November to April)
Total Dry Season Range (May to October))
18°00'S
Namibia
Botswana
N
Scale in km
0
50
Source: Caprivi Satellite Tracking Project
Cartography: Timothy Rodwell 1995

Table 5: Caprivi elephant home ranges derived from satellite telemetry of eight family herds and one bull elephant. Table also includes the approximate number of weeks each elephant spent out of Caprivi, and the percentage of the total time they were monitored that this represented.

Elephant ID No.	Where Collared	Home Range 100% M.C.P. (km^2)	Approx. # Weeks Outside Namibia	Approx. % Time Spent Out of Namibia
5760	Mahango G.R.	575	4	6
5761	W.Caprivi	3082	13	23
5762	W.Caprivi	1120	12	14
5765	W.Caprivi	5148	38	75
5766	W.Caprivi	2115	14	18
5767	W.Caprivi	1521	5	13
5769	W.Caprivi	5606	39	59
5763	Mudumu N.P.	2387	10	12
5764	Mamili N.P.	1895	12	15
Avgs.		**2605**	**16**	**26**
S.E.		**612.3**	**5**	**8**

Table 5 read in conjunction with Figures 8-16, show that while the wet season ranges outside of Caprivi are much larger than all the dry season ranges of the collared elephants, the amount of time spent outside of Caprivi by the collared elephants (excluding those elephants with movement pattern 3) was less than 25% of the total time they were monitored. Table 6 compares the home ranges of elephants in other regions of Namibia, and of the west and east coasts of Africa with those ranges observed in Caprivi.

Table 6: Elephant home ranges from VHF and satellite tracking in other parts of Africa compared to those observed in this study, and others like it in Namibia.

Locality	African Region	Home Range (km^2)
Lake Manyara N.P.	East Africa	15-52
Tarangire G.R.	East Africa	330
Serengeti N.P.	East Africa	>330
Tsavo N.P.	East Africa	1,532
Waza N.P.	West Africa	785-2,534
Sabi Sand Reserve	Southern Africa	<200
Etosha N.P.	Southern Africa	2,851-18,681
Kaokoveld	Southern Africa	3,059-15,422
Caprivi	Southern Africa	575-5,606

It seems from Table 6 that Namibia has some of the widest ranging elephants in Africa, although it is understood that comparable ranges might be found in other countries if they conducted satellite tracking experiments which allow one to track long distance movements move effectively. If more studies in Africa show the trend

in Table 6 to be accurate, then it is likely the high home range size can be directly correlated to Namibia and Botswana's relatively low human population, which might allow the elephants in these ranges, the freedom to move unrestricted through much of their range.

Fig 18a-18c indicate the approximate timing of the elephant movements in and out of Caprivi relative to rainfall. These figures also indicate how the elephants with movement pattern 2, return to their dry season ranges in Caprivi after spending a few months in Botswana or Zambia for part of the wet season. The movements out of the dry season ranges and into wet season ranges do not seem to preempt the rain as has been seen in other areas of Namibia and Africa. Generally, the Caprivi elephtants only start to move well into the rainy season, possibly to ensure enough time has passed to allow veld water to collect in a predominantly sandy environment, thus allowing them to spend more time away from the main rivers of the region.

6.3 Conclusions

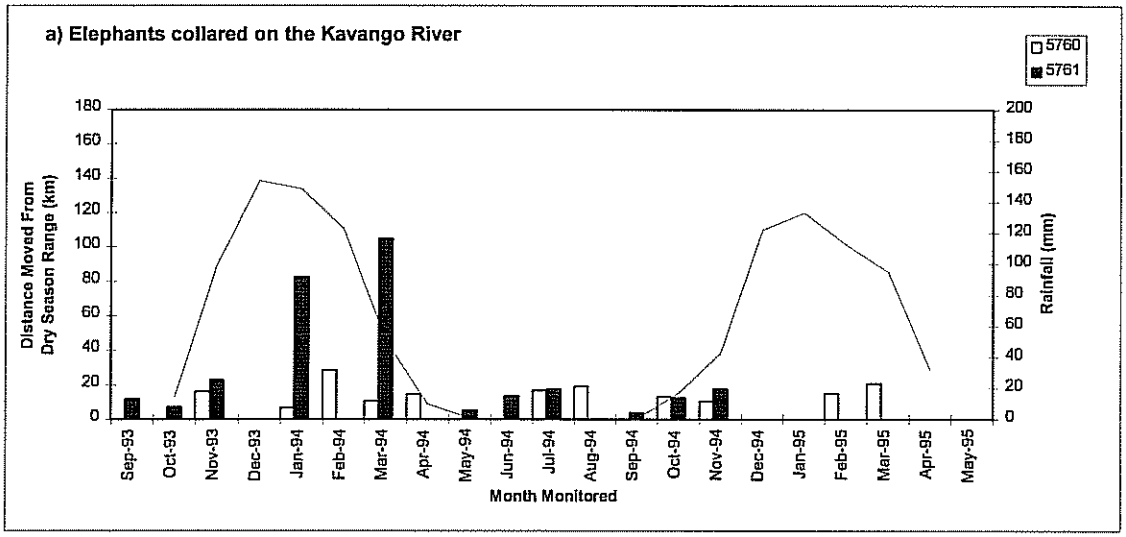
Despite initial equipment failures, the Caprivi elephant tracking component of this project was extremely successful. The present tracking system available in Etosha has many advantages over other options, but it is extremely time consuming to collect and analyse satellite telemetry data. The system is presently being upgraded to a more user friendly format, and will soon be available for additional testing.

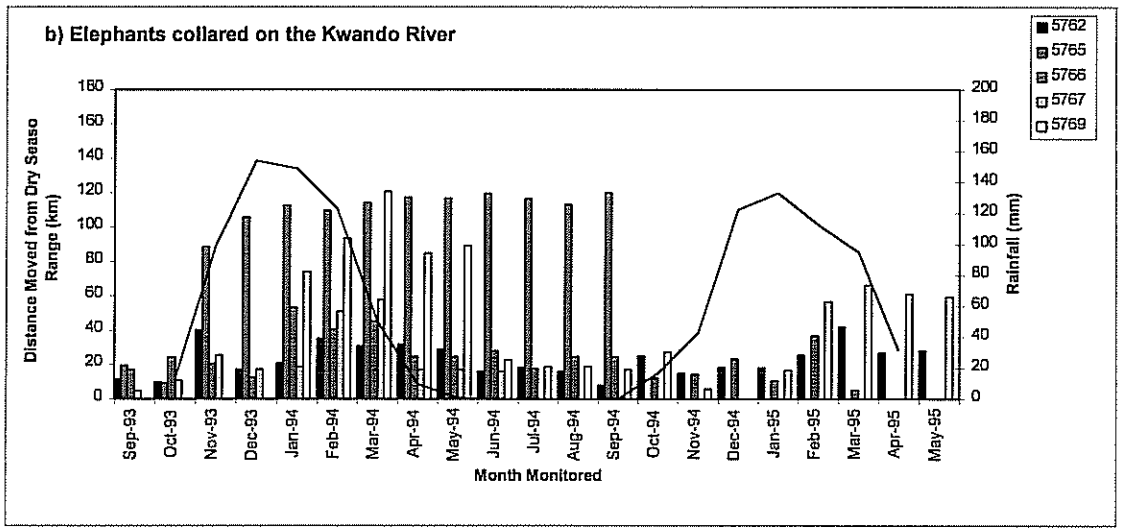
My reseasrch on the Caprivi elephants was a coarse resolution examination of large scale movements, and did not require pinpoint accuracy. If greater than a few kilometers accuracy is needed for future studies, I would reccomend using the new satellite transmitter collars that will be based on GPS technology, and will be accurate to a few meters. These collars used in conjunction with a real time receiver such as available in Etosha, will provide immediate and accurate satellite location information for detailed habitat use studies.

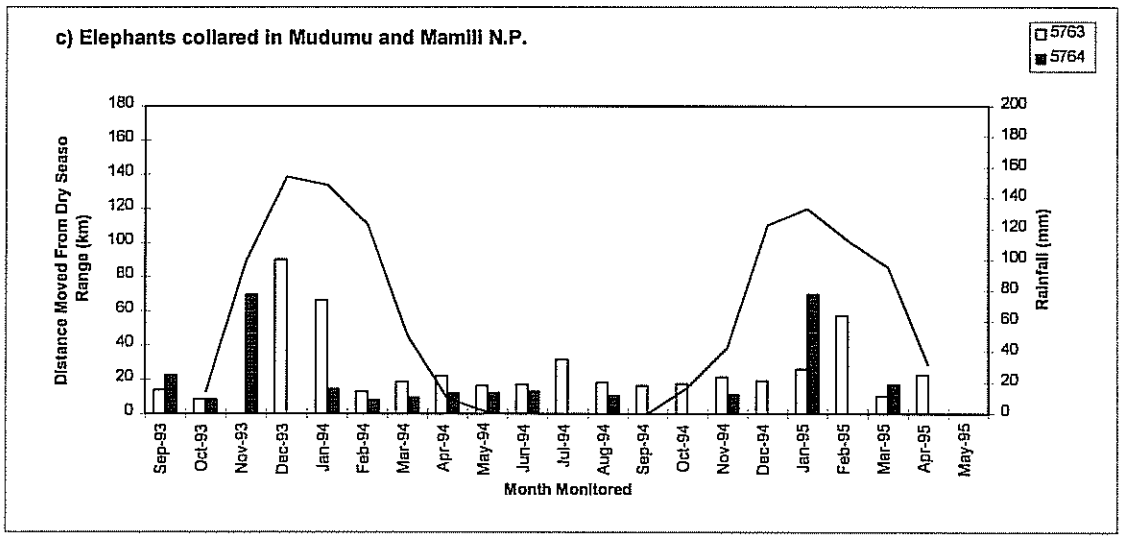
The majority of the elephants in the Caprivi in the wet and dry season are probably concentrated in the core areas of West Caprivi, and national parks in the East Caprivi. There is probably also use made of the central West Caprivi by elephants from Botswana. A wet season aerial census of Caprivi should confirm this probable distribution, and how many elephants are involved in this movement.

The small range of elephants in the Caprivi seems primarily to be the result of dense human settlement literally bordering all protected areas, and limited water supllies away from the rivers. Movements north into Angola are extremely limited, and for very short periods, most likely due to the worsening situation in the primarily UNITA held territory. Only movement south into Botswana is presently unrestricted by dense human settlements, and the majority of movements out of Caprivi occur in this general direction. Movements most likely to be jeopardized in the near future by human development are the movements North into Zambia, and the movements south from the Kavango River areas of Caprivi. The area due South of the "West Core" of West Caprivi is fast becoming covered in agricultural lands, and friction with

Figure 18: Distances moved by tracked elephants, away from the dry season ranges in which they were first collared, relative to the mean rainfall recorded at two stations on the Kwando River from 1993 - 1994







human settlements in this area and south in Seronga (where elephant 5765 was shot), could make movements through this region difficult. If pressure from UNITA north of the Kwando Core area continues, it is likely to have an effect on elephants in this region, and may influence their use of this area.

7.0 MORTALITIES

Understanding mortalities and demography of Caprivi Elephant herds is an important part of a complex picture of the ecology of elephtns in this region. I was however, not able to explore this component of the Caprivi Elephant Monitoring Project as fully as was needed. This was due mostly to my primary commitemtnts to the aerial census work of Caprivi in 1993 and 1994, and my technical assistance to the ELESMAP census of Namibia in 1995. Other difficulties that I underestimated were the difficulty of maintaining controlled field collection of data on mortalities.

The protected areas of Caprivi are not controlled environments in the same sense as other National Parks in Namibia. There are no fences between rural and protected areas, or between Namibia and Neighbouring countries, and Caprivi tribalism and shortages of resources and manpower contribute to the problems of effective management in these areas. These complications made it difficult to maintain controlled collection of elephant mortality data (without extensive personal input) in areas that could not be regulated in a consistant manner.

7.1 Methods

7.1.1 Observations

In 1992, the East Core region of West Caprivi was the protected area most consistantly patrolled by local MET staff, in an extensive manner. As this was the region with the highest elephant population, and the region in which I was based, it became the best place to initiate an elephant mortality reporting system. Jo Tagg (acting CNCO of the Caprivi) and myself set up a system of reporting, where all elephant mortalities observed on patrols by MET staff were reported with a grid-based location.

Carcasses were reported as:

Fresh - Flesh and vulture droppings present, probably died within two weeks of being found.

Medium - More than two weeks old, but still had skin on, probably less than one season old.

Bones - Only bones left, of indeterminate age

The MET staff also reported the sex, approximate age class of the elephant (Young, Sub-adult & Adult) and the probable cause of death. All MET staff asked to report these observations were trained by myself and Jo Tagg in the field and in the office to make accurate observations. Mortality books were placed in all MET field bases in

the Caprivi protected areas, but only Susuwe MET staff made regular and consistant reports of mortalities. MET staff were also asked to bring in the lower jaws of elephant mortalities found in the field

7.1.2 Aging
Whenever possible, I accompanied MET field staff to known elephant mortalities where I took the standard body measurements from which an elephant's age can be inferred:

Backlength	-Straight line from anal flap to the point where the ears join with the top of the head.
Shoulder height	-Sole of front foot, to the top of the scapula (where juts out of the skin).
Hind footlength	- Rear edge of hind foot, to the middle of the middle toenail.

Accurate aging of the elephants could only be estimated when lower jaws were available from elephant carcasses. As it was difficult to enforce the collection of these jaws, and as my time was limited by other activities, I did not collect nearly as many jaws as I had hoped .

Elephant lower jaws were aged from the left side of the jaw, using the method outlined by Laws (1966). Where other information such as footlength or backlength was available, ages were confirmed by comparing them with ages assigned to backlengths and footlengths as outlined by Laws (1966), Lindeque (1991) and Lee and Moss (1986).

The hind footlength of an elephant is a simple and quick measurement to make in the field, and in the absence of a more accurate aging method (such as tooth measurement in the lower jaw), seems to be a good field estimate of elephant age. Figure 19 indicates the relationship between elephant hind footlength and its true age. This figure shows a good fit for a log curve on the male data. The female data set included here is too small to seriously estimate a relationship for an age estimate based on foot size, and I include it more to indicate the importance of using separate functions to estimate the ages of males and females from footlength. Table 7 list footlengths and related ages from research in Caprivi and Amboseli, Kenya. Age estimates in this table were calculated from the functions shown in Figure 19 for Caprivi, and from the work of Lee and Moss (1986). The age estimates from the function in Figure 19 for male elephants in Caprvi seem comparable to those found in Amboseli male elephants, and are probably accurate enough to use for age estimation of Caprivi elephants, based on hind footlength. The Caprivi function for calculating female ages based on hind footlength does not seem accurate enough for use even as a rough estimate in Caprivi.

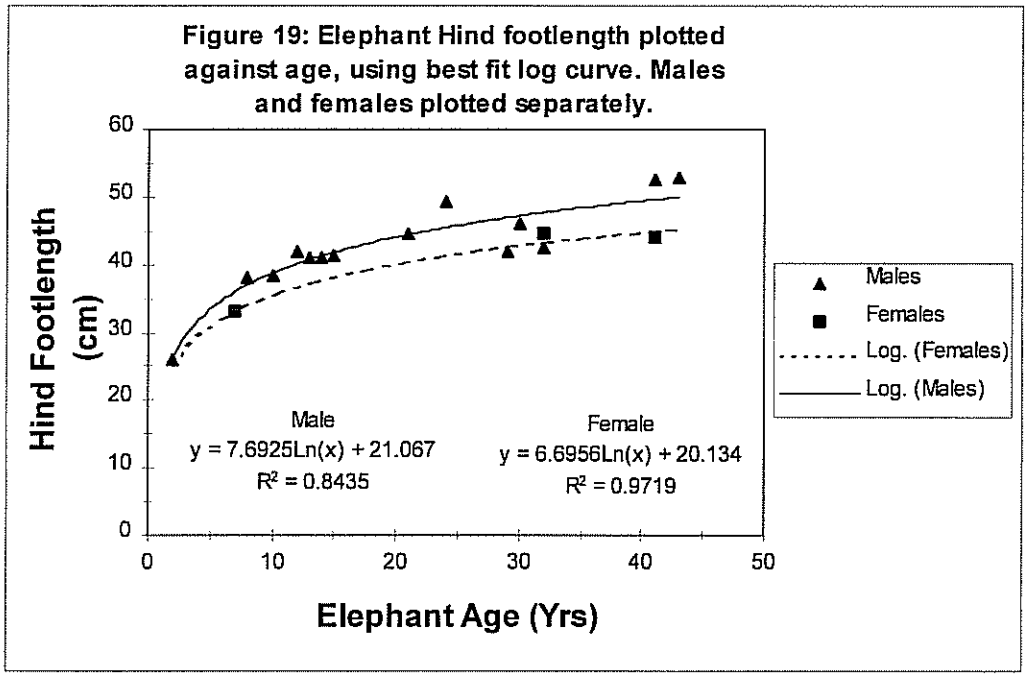


Table 7: Scale of approximate elephant ages assigned to hind footlength size in Caprivi, Namibia and Amboseli, Kenya. Blank cells show ages out of range of the equation used to calculate them.

FootLength (cm)	Male Age Caprivi *	Male Age Amboseli**	Female Age Caprivi *	Female Age Amboseli**
25	2	3	2	3
30	3	6	4	8
35	6	9	9	14
40	12	14	19	24
45	22	21	41	60
47	29	25		
49	38	30		

* Source: Figure 19

** Source Lee & Moss 1986

7.1.3 Disease

Anthrax samples in the form of swabs and soil samples were taken from almost all elephant mortalities observed by myself or MET staff. These samples were sent to Etosha N.P. where they were analysed for the presence of Anthrax spores by P. Lindeque. Over the course of three years, it seemed that anthrax spores could be detected more often in the soil samples than the swabs, and if work on anthrax continues here, I would reccomend that soil samples be primarily relied on for testing.

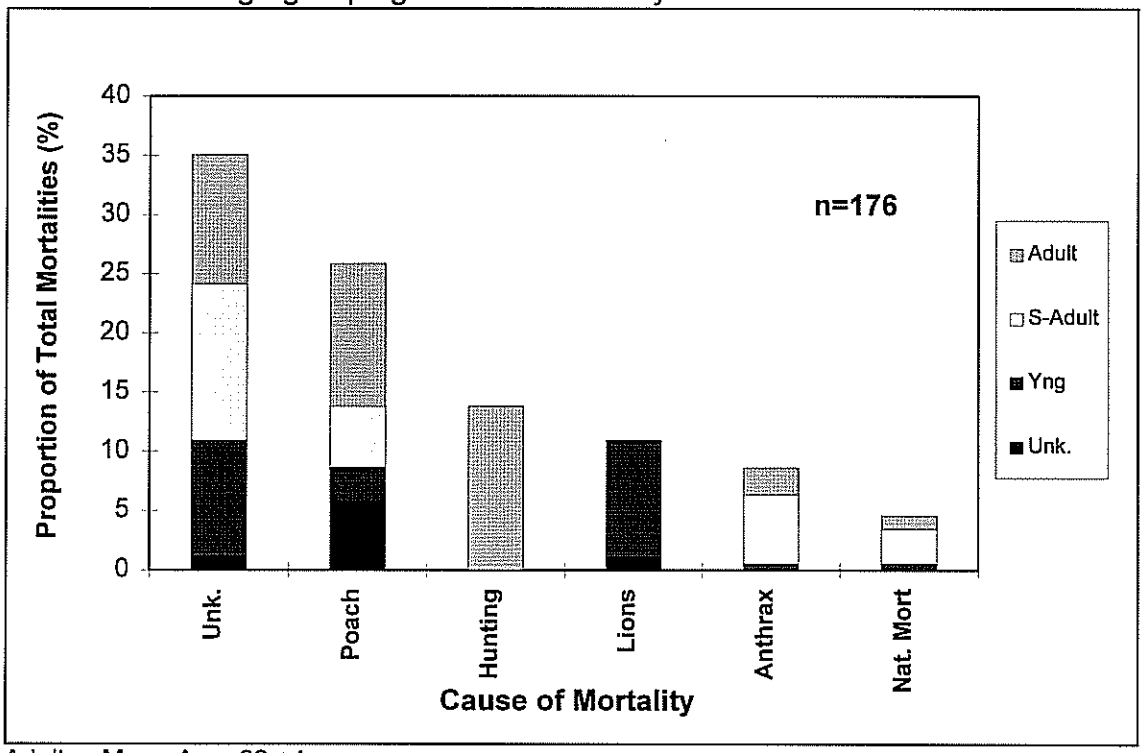
7.2 Results & Discussion

Approximately 176 fresh and medium (ie elephants that had unquestionably died during the period this project had monitored) elephant carcasses were reported in Caprivi between August 1992 and June 1995. Of these carcasses, about 126 (±71%) carcasses were reported from the East Core of West Caprivi. Other reports

came from other protected areas and from elephants hunted in Caprivi. I am confident this number of carcasses is an accurate representation of mortalities in the core protected areas as has been discussed in the Research Discussion Paper (Rodwell *et al* 1995) on the Caprivi censuses.

Figure 20 shows a summary of the major causes of mortality in Caprivi elephants as was observed from August 1992 to June 1995, as well as the age groupings contributing to each cause of mortality. The large number of unknown causes of death result primarily from carcasses that showed no poaching wounds (still had ivory intact), and they did'nt test positive for anthrax. As it is usually impossible to turn over a dead elephant in the field with no vehicle available, it is possible, many of the carcasses in this class have died from small calibre gunshot wounds that are not visible when MET staff find the carcass. Incorrect anthrax sampling could also account for some of these mortalities. The natural mortalities indicated in Figure 20, are the result of a variety of causes including being hit by cars and trucks on the Trans-Caprivi Highway, drowning and disease other than anthrax. One case of lung worm (identified by Dr. N. Brain) was recorded as a natural cause of death here.

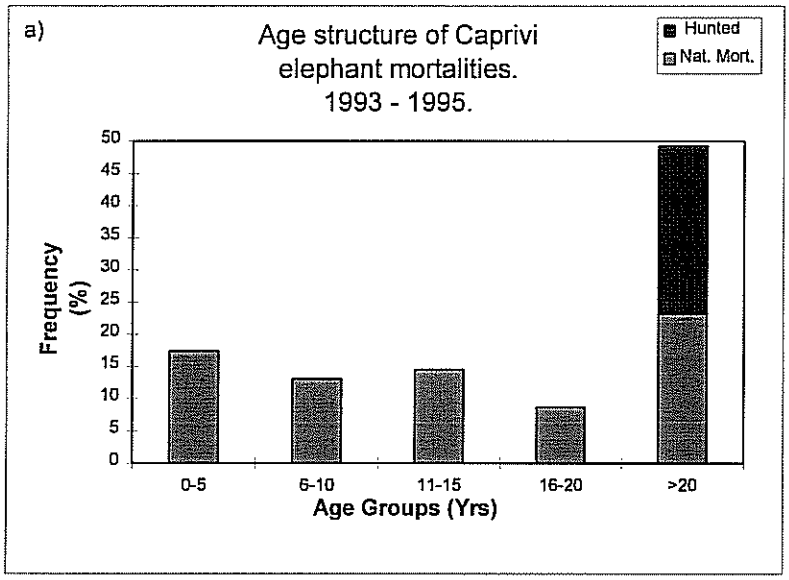
Figure 20: Factors contributing to Caprivi elephant mortalities, showing the contribution of age groupings to each mortality factor.

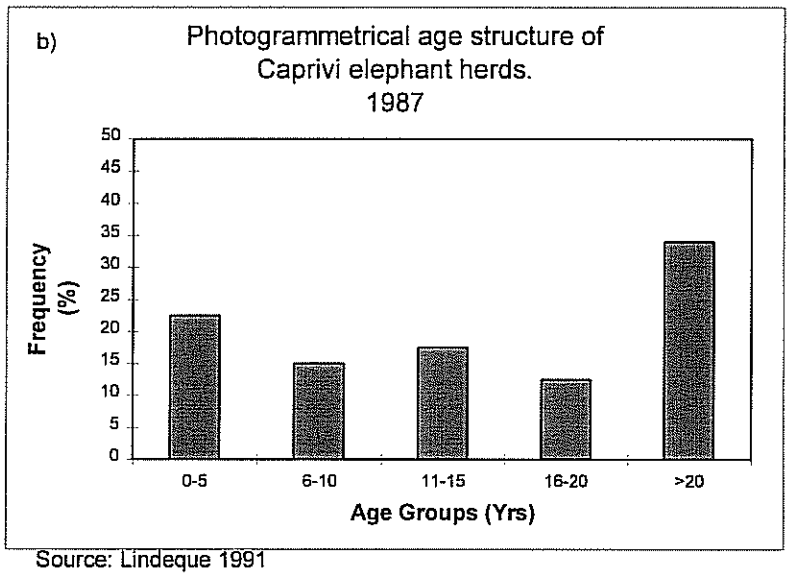


Adult Mean Age=32 ±4 yrs
S-Adult Mean Age=16 ±3 yrs.
Yng Mean Age= 5 ±2 yrs.

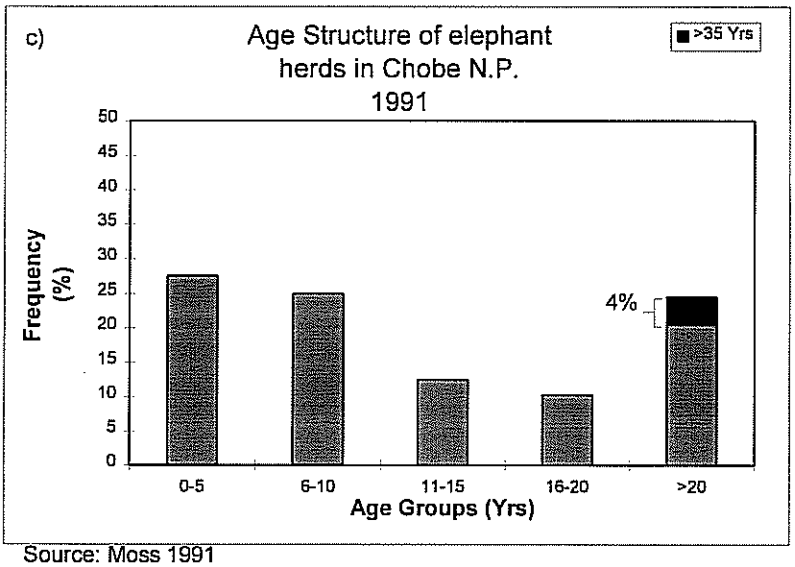
Figure 21a shows the contribution of known age elephants to the overall age structure of the Caprivi mortalities. Known ages come from jaws, or estimated from footlengths where available (Males by the Caprivi function, and females by the Amboseli function (see Table 7)). Figures 21a-c show how the age structure of the Caprivi mortalities compares with the age structure of the live Caprivi population as

Figure 21a-c: Age structure of Caprivi mortalities relative to age structure of Caprivi live population in 1987, and structure of population in Chobe NP.





Source: Lindeque 1991

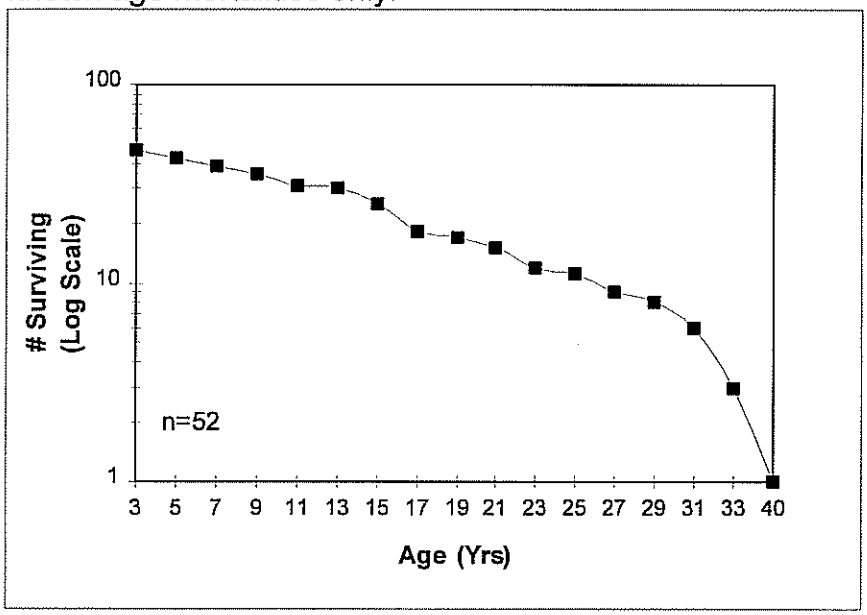


Source: Moss 1991

was in observed in 1987, and the age class structure of the population of elephants in Chobe N.P., Botswana . If hunting mortalities are exluded from Figure 21a, then the mortality age structure seems be a good fit to that of the live population observed in 1987 by Lindeque (1991) in Caprivi. This suggests that, excluding hunting, there seems to be no age class that has mortalities out of proportion with its age class of the live population. Hunting, however, pushes the mortalities of the >20 year old elephants out of proportion with this live class's percentage of the live population.

Figure 22 shows the survival curve for Caprivi elephants based only on the mortalities of known jaw age. All mortalities from hunting have been excluded from this figure as they are mortalities specifically aimed at a particular age class for a specific time. The purpose of this figure is to indicate the survival rate of different age groups in the natural Caprivi environment. Poaching mortalities have been included in this figure as they do not seem specific to any particular age class (personal observation), and they seem to be a "natural" and random component of the Caprivi elephant range.

Figure 22: Survival curve for Caprivi elephants, based on known age mortalities only.



The biggest problem with interpretation of Figure 22, is sample size (survival curves are usually compiled from hundereds of carcasses). It was pointed out to me that with a sample size of only 52, that if only **one** elephant mortality of over 50 years of age was found, this entire figure would look different. This observation is correct, and easily modelled in a spreadsheet as proof. It is, however, important to note that in three years I have not seen **one** mortality of over 45 years of age.

As tusk weight is proportional to age in bull elephants, elephant hunters are specifically biased in their search to find the oldest elephants they can, for a successfull hunt. Not one of the hunted elephants I have aged so far has been over 45 years of age. Finally, figure 21c shows the age strucure of the elephant

population of Chobe NP, (possibly a continious poulation with Caprivi's) to have only about 4% of its population over 35 yrs of age (Moss 1991).

This evidence taken together seems to indicate that although it is unrealistic to imagine there are no elephants over 45 years old in Caprivi, there are likely very few elephants in this age class in the Caprivi/Botswana population of elephants. It is therefore important to take Figure 22 in the context of other observations, and to not interpret it as it stands, but to use it as an indication of a possible trend in the Caprivi. As I clearly do not have enough data to make an accurate interpretation of survivorship, I include this figure to indicate something that needs to be further researched.

Figure 22 taken literally indicates all elephants in Caprivi die before the age of 40 years old. This is an inaccurate assesment (hunted elephants over 40 yrs old have been aged by me) resulting from the small sample size. What this figure possibly more realistically indicates, however, is that survival rates of Caprivi elephants drop rapidly after the elephants reach the age of about 30 yrs old. This rapid drop in survival rate only occurs at about 50 years of age in other national parks where survival curves have been compiled (Laws 1966).

7.3 Conclusions

Generally, the Caprivi elephant mortalities are not significantly high relative to the live population. At present, the majority of mortalties in Caprivi elephants are of unknown causes, with poaching and hunting being the next major factors in mortality. If the mortalities in the Kwando Core of the West Caprivi are an accurate assessment of total mortalities in that area, as they seem to be; and if the Caprivi population is growing at a similar rate to the elephant populations in Botswana (±4%/year) , then the present mortality rate represents about 35% of the annual growth rate of Caprivi's elephant population.

If the trend in mortality rates seen in Figure 22 is shown to be accurate by future work, there are two possible explanations for this trend:

1) Over hunting of elephants (male and female) for ivory, in the past, led to a removal of most of the population over about 30 yrs of age, and this age class is only now being replaced by elephants that were under 30 yrs old at the time of the over hunting.

2) Alternatively, elephants in the Caprivi and possibly Botswana population, for some reason, are not as long lived as those seen elsewhere, and they generally do not have high rates of survival after about 35 to 40 years of age .

8.0 DEMOGRAPHY

I have taken aerial photographs of elephant herds in the dry seasons of 1994 and 1995, which I had planned to use for the analysis of Caprivi herd age structure, as described by Croze (1972), and used by Lindeque (1991). I have not yet managed

to complete analysis of these slides to present here, but I will include this analysis in a final draft of this report.
As it is important that I provide an indication of possible Caprivi elephant herd age structure, I have included here, a photogrammetric analysis of Caprivi herd age structure from 1987 (Figure 21b). I have also included an analysis of age structure from Chobe National Park, Botswana, based on the assumption that this population which seems to share range with Caprivi elephants, probably has a similar age structure (Figure 21c).

Once I have completed analysis of elephant demography photos from 1994 and 1995, I will compare these age structures to those from Caprivi in 1987, and Botswana in 1991. One possibly disturbing aspect of the Chobe population age structure is the very small proportion of the total population that is over 35 years old (±4%). In Amboseli, Kenya for example, this class of the population is about 12% of the total population.

9.0 HUNTING

9.1 Introduction

The primary questions to be asked of Caprivi elephant hunting, is what is the present resource of trophy bulls in the population, and is the present hunting quota viable? If this question were asked of a totally enclosed and controlled population of elephants, to answer it fairly accurately would require knowledge of demography of the population, estimates of total poulation size, estimates of sex ratios, and some idea of survivorship and recruitment rates into the trophy age class.

9.2 Worst Case Scenario

If we ignore complications in Caprivi such as possible uncontrolled immigration from Botswana, and the unknown effect of a population of purely bull elephants in Mahango GR then it is possible to make some very broad estimates about the probable present availability of trophy elephants in Caprivi.

The minimum tusk weight considered for a trophy elephant is about 25 kg per tusk. Tusk weight is usually proportional to age in bull elephants, and Laws (1966) showed that a bull elephant needed to be about 35 years of age to have tusks of about 25 kg per side. This is comparable to Caprivi apparantly where the average tusk weight for Anvo Hunting Safaris in 1994 in West Caprivi was 24.5 kg/tusk, and the the average age for elephants hunted in West Caprivi in 1994 was about 36 years of age

In order to estimate the approximate proportion of the Caprivi elephant population presently available for trophy hunting, we need to estimate the bull proportion of the elephant population over 35 years of age. If in the worst case scenario it is assumed that the sources of the elephants for trophy hunting are primarily the core elephant populations of Caprivi, then Table 8 indicates the possible existing trophy resources for the dry season in Caprivi, and the percent of the trophy class that present quota allocations might represent.

Table 8: The possible source elephant populations for hunting in the Caprivi, showing the proportion of each population that is probably available for trophy hunting, relative to the present allocated number of trophies for each of these areas, and what percent of the trophy population these allocations represent.

	West Core	East Core	East Caprivi
Total Elephant Population size*	1500	2900	1000
Probable number of population > 35 yrs.**	60	116	40
Possible number of trophy bulls***	30	58	20
Number of trophy elephants allocated****	5	2	8
Proportion of possible trophy class allocated for hunting (%)	17	3	40

* Table 1

** Based on the percent of the Chobe population >35 yrs. (Figure 21c)

*** Based on male to female ratio of 1: 1

**** Source MET

9.3 Conclusions

If this worst case scenario is even partly accurate, and the mortality rates in Figure 22 are indicitive of what is occuring to elephants over about 35 years of age, then trophy hunting at its present rate may not be viable in Caprivi for the long term.

Fortunately for Caprivi elephant hunting, the worst case scenario presented here is greatly simplified and probably not accurate. There are definately bull elephants crossing into Caprivi (personal observation), and the immigration of trophy bulls is almost impossible to quantify with present information. It is possible for example, that the entire present hunting quota of trophy elephants is supplied by immigration from Botswana.

What is probably very important in determining the status and trends in trophy hunting viability, is information from the hunters themselves. Information such as hunting effort expended for each trophy, and trophy weights over the years, will probably provide more insight than scenarios such as that presented here, when there are so many unknown variables that have to be assumed. The scenario in Table 8, together with information on mortality rates and survivorship, should however be seen as an indication that there might be a problem with long term hunting viability in the Caprivi, and more work should be aimed specifically at this question to either confirm or dismiss these indications.

10.0 OTHER ACTIVITIES

Other activities not reported here took a great deal of my time during this project, and were more process orientated than product oriented activities. These activities included :

. Providing technical assistance to the Caprivi Elephant/Human conflicts project and IRDNC community conservation staff.

. Assting Caprivi C.N.C.O with development of grid-based wildlife oberservation and mapping system.

. Providing technical assistance to the ELESMAP census of Namibia for 1995.

. Providing various MET staff with computer mapping technical assistance.

11.0 CONCLUSION

The Caprivi strip has five primary elephant ranges and other possible temporary ranges. Evidence from this project indicates the primary elephant range of Caprivi is the Mahango GR, East and West Core areas of West Caprivi, and Mudumu and Mamili NP's. Other evidence not explored in this project suggests there is temporary elephant range in the central region of West Caprivi in the wet season, and posibly some temporal use of habitat in the Eastern floodplains and Chobe river areas.

There are approximately 6000 (Including Mahango GR) elephants resident in Caprivi in the primary ranges during the dry season. Based on the movements of nine satellite collared elephants, the majority of these elephants probably use Caprivi range for over 50% of the year, and Botswana range for a part of the wet season. Movements from Mudumu NP suggest range in Zambia is also used for a small part of the wet season.

Movements of Caprivi elephants generally seem to be restricted by human settlements and limited water availability. If Movements out of Caprivi protected areas into surounding areas in Caprivi are to be encouraged, for hunting and conservancy utilization, then areas such as that planned to link Mudumu and Mamili NP's probably need to be made free of human settlements and agricultural land, and water supplies need to be established to lure the elephants away from the rivers.

Elephant movements into Botswana ranges seem to be primarily related to rainfall. These movements not only keep Caprivi and Botswana elephant populations in contact with each other, but also the different Caprivi populations that seem to be isloated from each other for most of the year. It is vital that the main movement corridors between Caprivi and Botswana are kept free of human settlement to ensure these populations remain open to each other. If these corridors are cut, elephants in the very small core areas of Caprivi will have to be manged intensively to maintain a balance between habitat and viable population numbers.

Mortalities in the Caprivi do not seem to be cause for concern at present. There is poaching in all Caprivi range, and it is probably increasing in the Kwando core area as result of UNITA incursions, but it is still a low enough proportion of the live elephant population not to cause alarm. Pressure from Angola could, however, seriously impact movements and distribution of the elephants in the Kwando Core

area, and this, together with reasons of tourist development in the area, should provide sufficient motivation to ensure that the Kwando Core area is regularly patrolled, and that the Angolan's are kept out.
Anthrax does occur in elephants in Caprivi, and seems to fluctuate seasonally and annually in terms of severity and timing.

There seem to be indications that Caprivi elephants over the age of about 35 years are a very small proportion of the total population, and that elephants reaching this age do not have a good chance of survival past about 45 years of age. This possible trend needs to be looked at in more detail in order to confirm or dismiss it.

The viability of trophy hunting of elephants in Caprivi is extremely difficult to asses with the huge unknown variables such as possible immigration of trophy elephants from sources in northern Botswana. Signs such as the possible low number of trophy age bulls in the present dry season populations, and the possible high mortality rate after age 35, need to be assesed in detail to confirm whether these indications are accurate or not. Probably of more immediate concern for elephant hunting in Caprivi is the question of elephant range in Caprivi. If the elephants are truly not using much range outside of protected areas at present as the satellite movements indicate, then it will prove very difficult to find enough trophy animals outside of protected areas regardless of their proportion in the population.

The present biggest threat to elephants in Caprivi and Botswana is probably living space. The elephant populations in this region of southern Africa have been shown to be stable or increasing for many years, and mortalities seem to be generally below probable recruitment rates. The space that these elephants can use, however, is becoming smaller every year. East Caprivi has one of the highest human birth rates in Namibia, and the borders of Mudumu and Mamili National Parks are constantly being challenged by rural communites. If present plans to return wildlife revenue and benefits to rural communities is successful, there is a good chance the rural settlements in Caprivi can be convinced to make space, or at least not take any more space away from the preciously small ranges used by elephants in Caprivi. This direction of wildlife management in Caprivi, together with co-operation with Botswana officials to keep international corridors, settlement free, will be vital in maintaining the present elephant populations and their distribution patterns.

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APPENDIX 1

Report Submitted to MET May 1995

Elephant Shot in Botswana
from: report of Problem Animal Control (PAC) officers, Maun, Botswana. ref #:wp/adm/8/3/5 III (7), 15 Sept. 1994.

On a date unknown, villager, Lobatse Ngande, a resident of XAA settlement (18°53.24'S/22°30.71'E) in the Seronga region of Okavango Delta, Botswana was killed by an unidentified elephant.The Maun PAC unit under Senior Game Warden Mr. T.Paul responded, and arrived in the region on August 24 1994. This team tracked down three elephants to approximately Gunitsuga (18°50.27'S/22°34.28'E) settlement, and killed a cow that allegedly charged them from the group of three elephants.

This cow was later discovered to be wearing the satellite/VHF collar that was originally fitted to the elephant on the Kwando River in the Caprivi region of Namibia about 3km SE of Horseshoe (17°57.35/23°17.34'). This position is approximately 124 km from where the animal was shot, and represents the culmination of almost exactly 1 year of satellite tracking of its position. The satellite/VHF collar was removed by the PAC unit and returned to Maun, where I retrieved it from them after receiving satellite locations from Maun vicinity for many months (see quarterly report 01/95-03/95).

A total of 13 elephants were shot in the Seronga region while the PAC unit was there. They hoped this would ease the considerable burden on the villagers of this region who were reportedly being continually harassed by large numbers of elephants.