
**REPORT ON THE AERIAL ELEPHANT CENSUS OF THE
CENTRAL LIMPOPO RIVER VALLEY, SOUTHERN AFRICA
SEPTEMBER 2010**

By

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INTRODUCTION

The Tuli elephant population is one of the important cross border populations on which very little intensive scientific data pertaining to numbers and movements has been collected. This is a more or less free ranging population, in that there are only a few fences and human settlements that influence movement. But this is changing rapidly. In light of the proposed Greater Mapungubwe Trans-Frontier Conservation Area, and the developing agriculture, mining, dam construction and other settlement in the region, information on the numbers, distribution, movements and dynamics is essential for proper management to avoid human-elephant conflicts and habitat destruction and loss of biodiversity. The numbers, distribution, social structure, and demographics of this population are as yet not thoroughly understood. In particular impacts from legal and illegal hunting and dispersal out of the area are not quantified. Aerial surveys provide information on numbers, group structure and distribution that are important baseline data pertinent to basic ecological questions and conservation planning and management.

An aerial survey of the study area was thus undertaken on the 11th – 12th September 2010. The objective of the survey was to determine the distribution and population total of the Central Limpopo River Valley elephant population in the previously identified range.

BACKGROUND TO THE STUDY

The Tuli elephant population occurs in three different countries namely Botswana, South Africa, and Zimbabwe.

Land use by people is different in different parts of the elephant range and different agencies currently manage the elephant population differently when they are in different parts of the range. In Botswana the area along the Limpopo consists of a number of adjoining farms, which form an area known as the Tuli Block (Fig. 1). The Northern Tuli Game Reserve in Botswana consists of a number of privately owned farms bounded by the Limpopo, Motloutse and Shashe rivers. It comprises about half of the area of a conserved ecosystem which consists of the Tuli Circle Safari Area and the Mlala Reserve in Zimbabwe, and Mapungubwe National Park in South Africa. Several wildlife based tourist operations occur in the Tuli area and depend on the presence of elephants for their success. To the west (Bobirwa sub district) and east (Maramani) of the Northern Tuli Game Reserve (NTGR) is communal land. Land use in the communal lands consists of subsistence agriculture and stock farming. Two privately owned farms (Sentinel Ranch and Nottingham Estate are bounded to the west by Maramani and to the south by the Limpopo River. In the South African part elephant range are restricted to Mapungubwe National Park. Along the Limpopo River several citrus and crop irrigation farms occur.

First records of elephants in the region were about 1945 (Page, pers. comm.). It is probable that elephants were reduced to very low numbers or shot out in the region between the early 1800's and the 1940's, as was the case in almost all of Southern Africa (Hall-Martin 1987). From the 1940's onwards the region that is now the Northern Tuli Game Reserve appears to have formed the core of the elephant population range (Walker 1971).

The first estimate of the population in the region in the late 1970's was 1200 (Feely 1975; Nchunga 1978). The first aerial survey of the Northern Tuli Game Reserve was conducted in

June 1976, which counted 498 elephant in the NOTUGRE area (Walker (1976a) as quoted by Page 1980).

Regular aerial censuses of the NOTUGRE area have been undertaken since 1976. Data from the counts show that in the Northern Tuli Game Reserve elephant numbers fluctuate, between different months in the same year as well as between different years in the same month. Analysis by Cheney (1998) suggests that the movements may be related to rainfall in the region, but the trends are not clear.

When the first scientific counts were begun in 1976, the civil war in Zimbabwe (then Rhodesia), prevented a count in the entire region. Walker (1971) attempted from interviews and the surveys conducted in Botswana to define the range. A collaring exercise in 1977 (Page 1980) attempted to establish the range more precisely, but again because of the civil war in the then Rhodesia, this failed. To date the precise range used by the population, their numbers, social structure, age structure and sex ratios have not been determined.

In 1999 the range of the elephant population was determined from a literature survey, questionnaires, interviews and by recording signs of the presence of elephants in the region surrounding the NTGR. From the initial survey the region bounded by latitudes 21° 00' and 22° 40' south and longitudes 27° 30' and 30° 00' east, an area of some 185 km x 260 km, was defined as the potential range (Fig. 1). Five total aerial counts were conducted within subsections of the previously identified potential range in August 2000, July 2001, October 2004, July 2007 and August 2008. Totals of 1262, 1294, 1240, 1080 and 1229 were recorded with the highest numbers in all counts in the Botswana section of the study area. Four and possibly as many as seven sub groups within the population were identified.

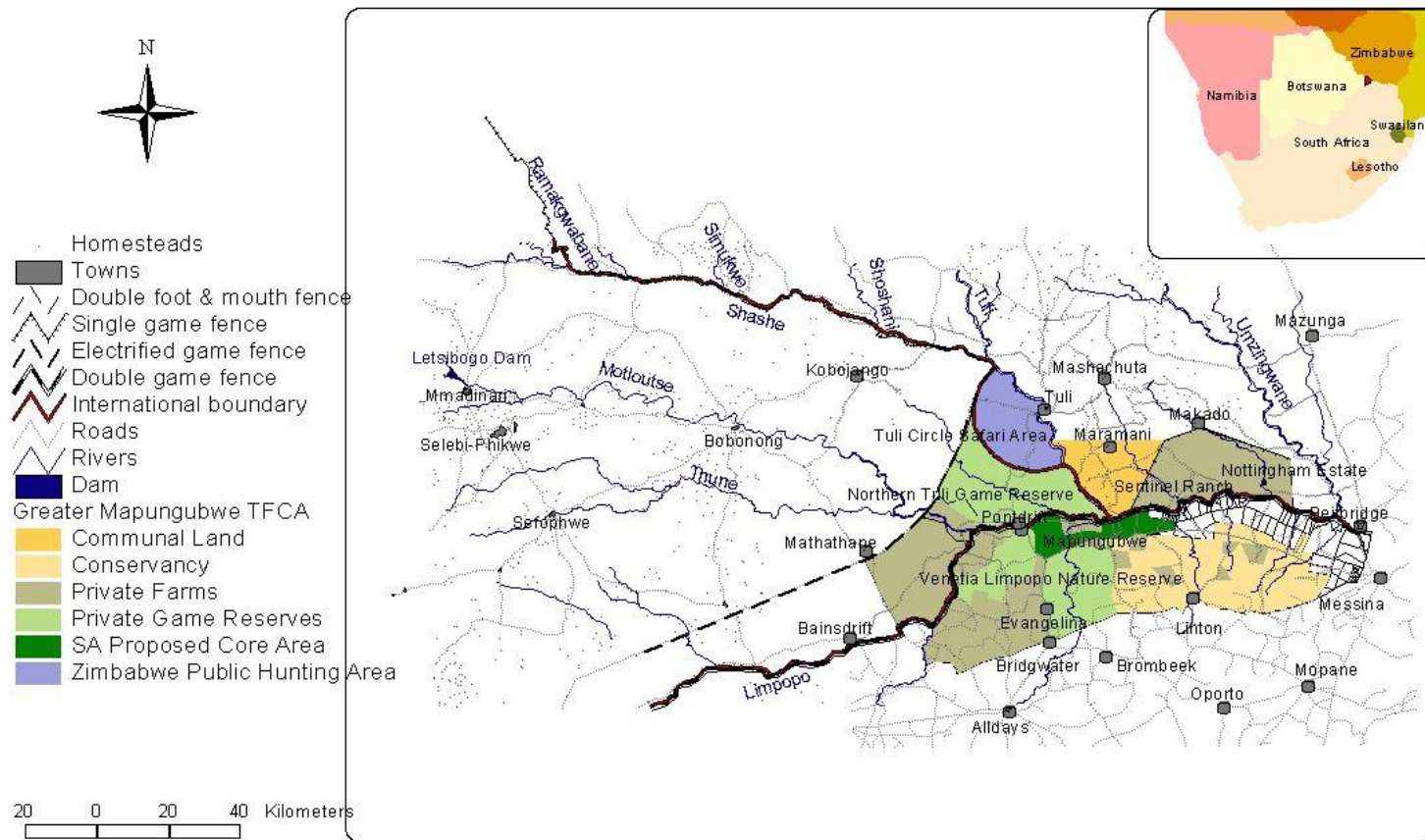


Figure 1: The Central Limpopo River Valley between 21° 15' and 22° 40' South and 27° 30' and 30° 00' East, showing the major rivers, roads and settlements, and the location of the Northern Tuli Game Reserve.

METHODS

A total aerial count of the Central Limpopo Valley elephant population was conducted over a two-day period (11 -12 September 2010). The methodology was similar to those of previous years. Three fixed wing aeroplanes (Cessna 206; two C182T) were used to count the study area simultaneously. A team consisting of a pilot, navigator and two observers were used. The two observers, one positioned on each side of the aircraft recorded counted elephants on either side of the aircraft and relayed the information via an intercom to the navigator, who also recorded the position of the aircraft. Data and flight paths for the Northern Tuli Game Reserve and Mapungubwe National Park were recorded on a Cybertracker and combined with photographs taken of the various elephant groups encountered.

Flight lines ran roughly parallel to the Shashe River in a north-south direction for the entire study area. Transects were 1 km wide (500m each side of the aeroplane) and flying height 100 m to 150 m with a flight speed of 90-100 knots. The transect width was set at 1 km due to the openness of the area (Plate 1). Flight times were restricted to early mornings 07h00 – 1100 for the duration of the count.



Plate 1: Elephants from the air showing the openness of the terrain.

The area was divided so that the start and end of transects flown by different aeroplanes and on successive flights by the same aeroplane would ensure that double counting did not occur. On day one the Northern Tuli Game Reserve (Botswana), Mapungubwe National Park (South Africa), the Tuli Block from the Motloutse River to Zanzibar and Sentinel Ranch, Nottingham Estate, River Ranch (Zimbabwe) were counted. On day two the Tuli Circle in Zimbabwe and the major

rivers (Motloutse and Thune) in Botswana, the Shashe River from the Tuli Circle to the confluence of the Ramokgwabane and the Shashe River as well as Letsibogo Dam were counted. Within the communal areas of Botswana a 1km transect were flown along the Shashe River towards the confluence of the Shashe and Ramokgwabane River. From the confluence a transect south towards Letsibogo Dam was flown. A 4 km area in the vicinity of Letsibogo Dam were surveyed comprising of approximately eight transects. From the dam a 1 km transect was flown along the Motloutse River to the confluence of the Thune and Motloutse rivers. A 1 km transect was flown up along the Thune River and back down one of the tributaries to the Thune towards the Motloutse River. On transects along the rivers, visible elephant impact were recorded. (See Appendix A for flight paths)



Plate 2: Counting team for the elephant count

RESULTS

Weather conditions during the aerial count were good with little to no cloud cover, and minimal wind.

2010 Census

During the 2010 count a total of 1237 elephants were counted. A total of 743 elephants occurred in the NTGR-MNP-TSA section of the range, while 190 elephants were counted in the BDMRF, 304 elephants in the SNRC, and none in the LDNS sections (Fig 2).

Comparison with Previous Total Counts

The census total of 1237 was similar to previous years, as was the 743 in the NTGR-MNP-TSA section. The 190 in the BDMRF are substantially lower than in previous years, and the SNRC and LDNS counts are higher (Table 1).

Apart from the differences in density, the distribution in different parts of the range is similar to that in other years (Fig 3).

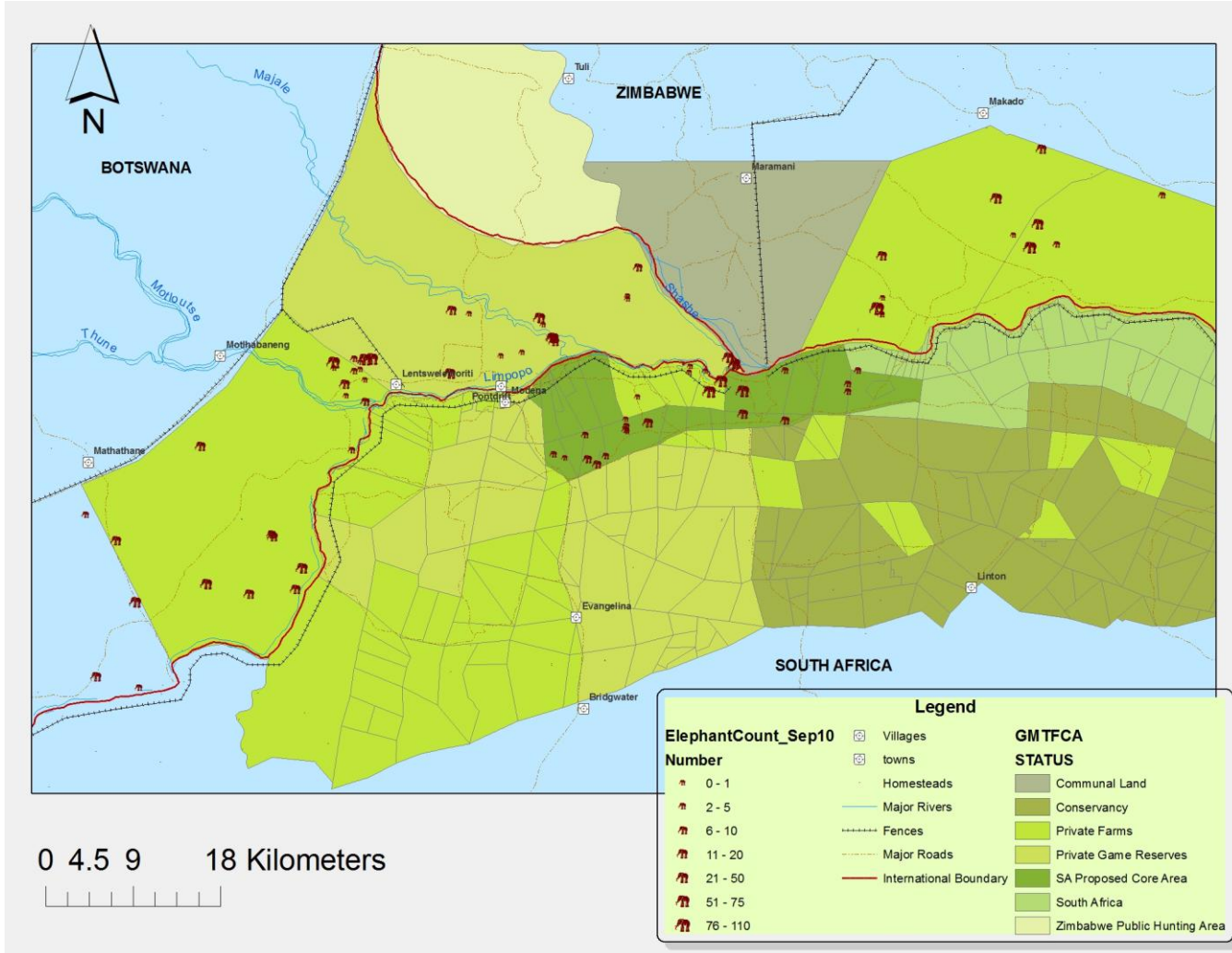


Figure 2: Elephant distribution and group sizes during the September 2010 total aerial count conducted in the Central Limpopo River Valley.

Table 1: Comparison of the results of the six total aerial counts of the Central Limpopo Valley elephant population. NTGR – Northern Tuli Game Reserve, MNP – Mapungubwe National Park, TSA – Tuli Safari Area, BDMRF – Baines Drift to Motloutse River Farms, SNRC – Sentinel Ranch, Nottingham Estate, River Ranch Complex, LDNS – Letsibogo Dam and Northern Shashe Area, MTRR – Motloutse and Thune Riverine

Sub population	Management Area	Total Counted					
		Aug 00	Jul 01	Oct 04	Jun 07	Aug 08	Sep 10
NTGR-MNP-TSA	Botswana - NTGR	512	877	291	603	476	461
	RSA - Mapungubwe - Limpopo Riverine	0	0	0	2	3	67
	RSA - Mapungubwe - Greeffswald	0	10	2	0	4	69
	RSA - Mapungubwe - Schroda	0	0	0	0	15	29
	South Africa - Ratho	0	2	5	0	0	0
	South Africa - Den Staat	0	1	0	0	53	1
	South Africa - Samaria	5	2	0	0	0	71
	South Africa - Little Muck	0	0	0	113	11	45
	Zimbabwe - Tuli Safari Area	57	0	0	3	0	0
Sub total		574	892	298	721	562	743
BDMRF	Botswana - BDMRF	373	288	522	244	636	190
	Sub total	373	288	522	244	636	190
SNRC	Nottingham & Sentinel	170	104	20	115	31	304
	Zimbabwe - Zhove Dam	0	0	250	0	0	0
	Sub total	170	104	270	115	31	304
LDNS	Shashe Riverine	120	10	0	0	0	0
	Botswana - Letsibogo Dam	25	0	150	0	0	0
	Botswana Communal Area	0	0	0	0	0	0
	Sub total	145	10	150	0	0	0
TOTAL		1262	1294	1240	1080	1229	1237

* Zhove Dam is an estimate from verbal reports.

** Count along the Limpopo River, not a total count of area.

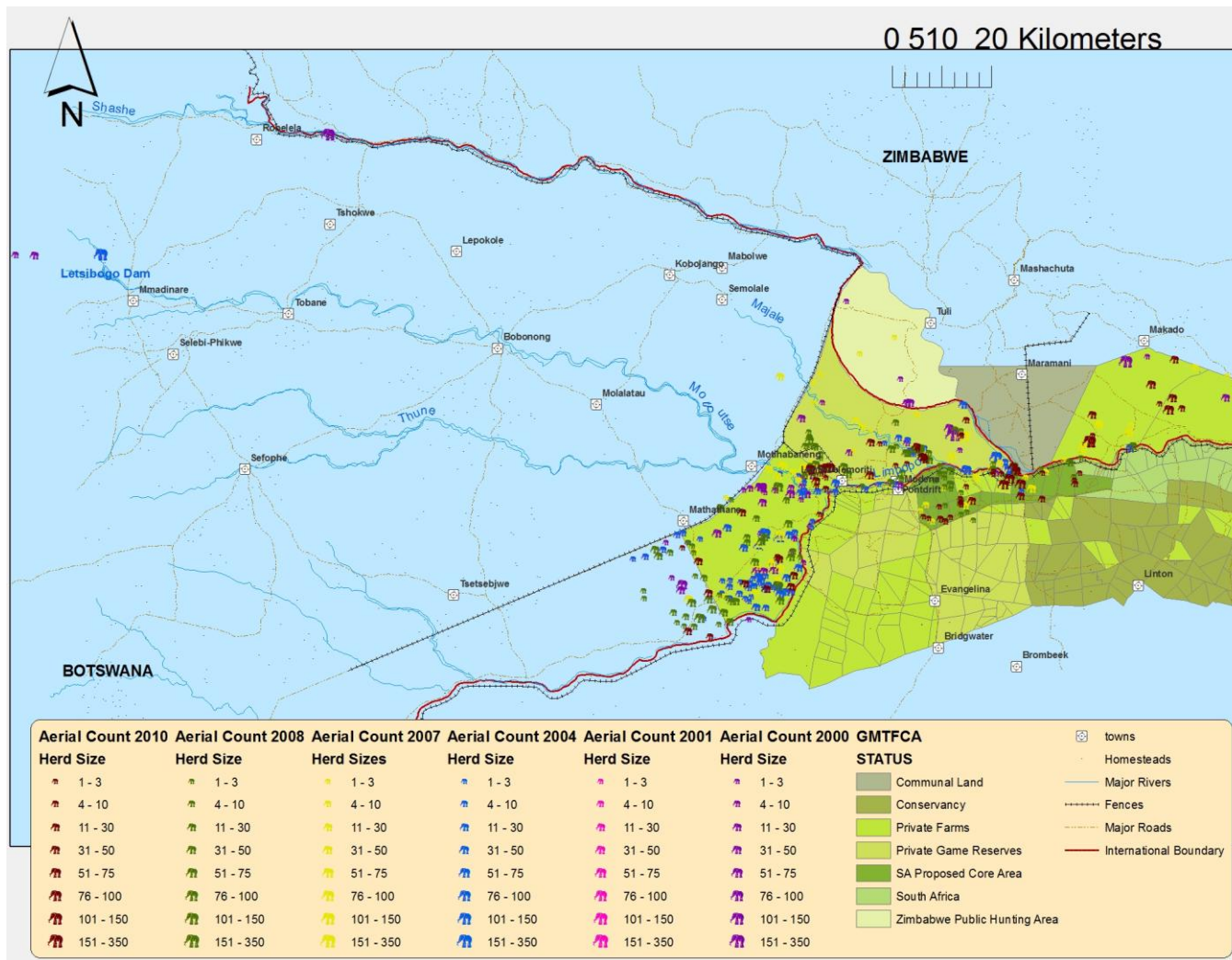


Figure 3: Comparison of elephant distribution between six total aerial counts conducted in the Central Limpopo River Valley.

The highest density of elephants occurred within the Botswana section of the study area (Table 2). Highest concentration as expected was found in protected and semi protected areas (NTGR; MNP; BDMRF), which also have the highest number of water points in the region, which may account for the distribution.

The total number of elephants counted in 2010 was 1237 compared to 1262, 1294, 1240, 1080 and 1229 in 2000, 2001, 2004, 2007 and 2008 respectively (Table 1). This figure is similar to the 2004 and 2008 count but slightly lower to the counts of 2000 and 2001 and higher than the count of 2007.

Figure 4 shows at least four distinct core areas with distributions west of the Motloutse River, in the NTGR, in the Sentinel - Nottingham area, and in the Shashe - Letsibogo Dam area. These relatively fixed winter ranges suggest the possibility of different clans or bond groups in each of the areas. Closer examination of Figure 4 indicates seven possible clusters associated with the larger rivers draining into the Limpopo River. These groupings appear to be associated with (i) the Pahzi and Umzingwane rivers in Zimbabwe, (ii) the lower Shashe River and its junction with the Limpopo River, (iii) the Majale River between the Shashe and Motloutse in Botswana, (iv) the drainage east of Lentswe le Moriti, (v) the lower Motloutse River, (vi) the section of the Limpopo River east of Baines' Drift, and (vii) the upper reaches of the Motloutse River around the Letsibogo Dam.

Table 2: Elephant density distribution within NTGR – Northern Tuli Game Reserve, MNP – Mapungubwe National Park, TSA – Tuli Safari Area, BDMRF – Baines Drift to Motloutse River Farms and SNRC – Sentinel Ranch, Nottingham Estate, River Ranch Complex

	Area km2	Aug-00		Jul-01		Oct-04		Jul-07		Aug-08		Sep-10		Ave Density	Max Density
		Total	Density	Total	Density	Total	Density	Total	Density	Total	Density	Total	Density		
Northern Tuli Game Reserve - Botswana	720	512	0.71	877	1.22	291	0.40	603	0.84	476	0.66	461	0.64	0.75	1.22
Tuli Safari Area - Zimbabwe	500	57	0.11	0	0.00	0	0.00	3	0.01	0	0.00	0	0.00	0.02	0.11
Baines Drift - Motloutse River Farms - Botswana	600	373	0.62	288	0.48	522	0.87	244	0.41	636	1.06	190	0.32	0.63	1.06
Mapungubwe & Other Farms - South Africa	280	5	0.02	15	0.05	7	0.03	115	0.41	86	0.31	282	1.01	0.30	1.01
Nottingham & Sentinel - Zimbabwe	760	170	0.22	104	0.14	270	0.36	115	0.15	31	0.04	304	0.40	0.22	0.40
	2860	1117	0.39	1284	0.45	1090	0.38	1080	0.38	1229	0.43	1237	0.43		

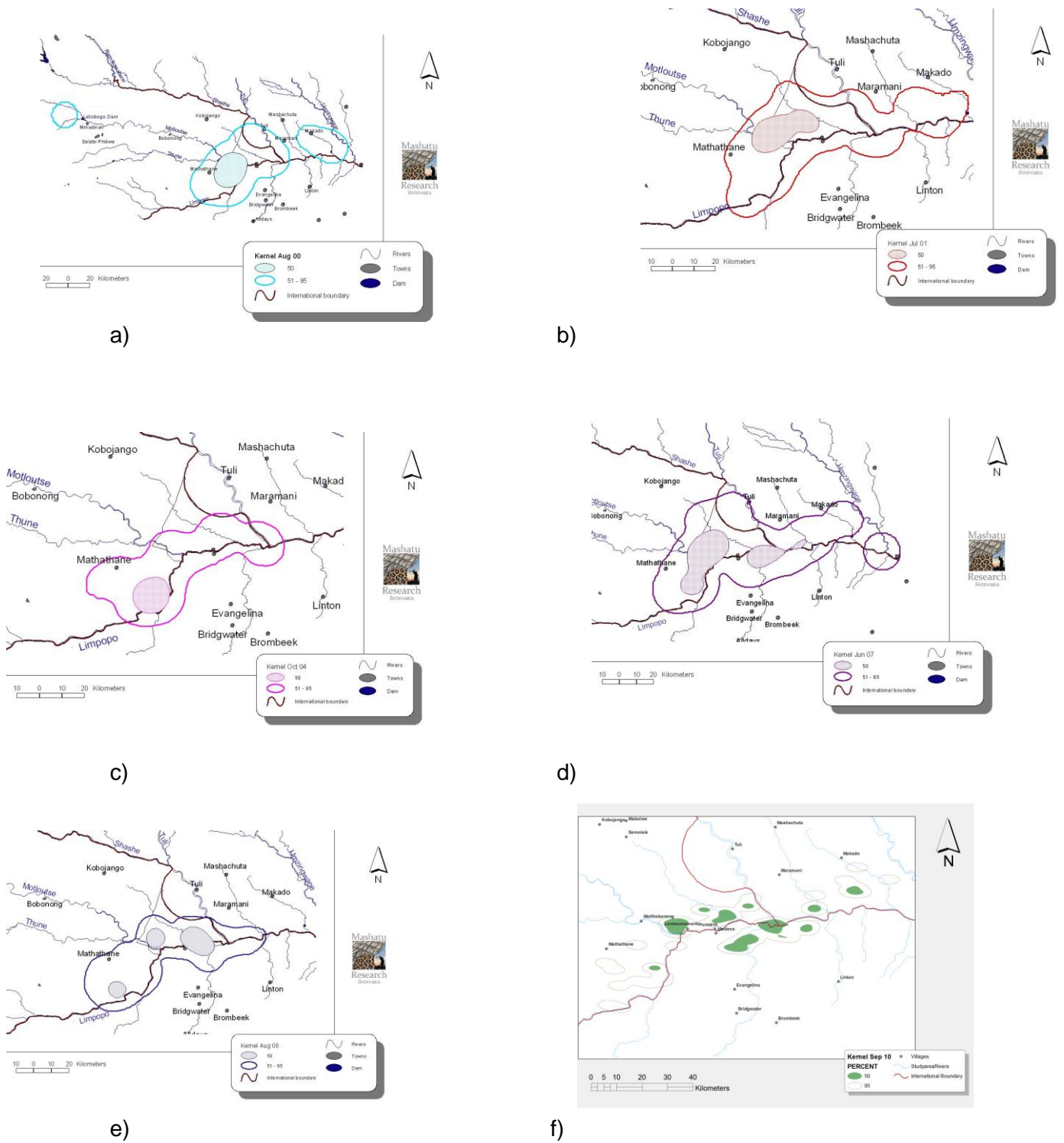


Figure 4: Kernel analysis showing the 50 percent and 95 percent kernels for each of the five censuses a. August 2000, b. July 2001, c. October 2004, d. June 2007, e. August 2008 and f. September 2010.

Group size structure

The number of groups counted was 54, 105, 82, 61, 111 and 76 for the respective counts in 2000, 2001, 2004, 2007, 2008 and 2010 (Table 3).

The average group size for 2000 (35) was biggest recorded. Average group sizes recorded for 2001 (19), 2004 (18), and 2008 (17) were very similar, while average group size recorded in 2010 were the same as recorded in 2007 (28).

The total annual rainfall for the 1999 / 2000 season was 925.9 mm, and for the 2000 / 2001 season 154.5 mm. The 257.3 mm during the 2003 / 2004 season followed two years of below average rainfall, making this the worst of the three seasons, while the total annual rainfall for the 2006 / 2007 season was 293.1 mm and the 2007 / 2008 season was 458 mm (Fig. 5). The census in 2004 was later in the year (October compared to August in 2000 and July in 2001), while the 2007 census was earlier in the year (June) following a season of late rainfall. During the 2007 / 2008 rainfall year, rain was received early in the season but little rain was received after March 2008. During the 2009/2010 season high rainfall was received during November and again late in the season during April. These results suggest that group size is related to rainfall with fewer, larger merged herds occurring in early or wetter winters and more, smaller herds in late winter and in drier seasons (Fig. 6 & Fig. 7).

Table 3: Comparison of results on elephant numbers between the six total aerial counts conducted within the Central Limpopo Valley

	Aug 00	Jul 01	Oct 04	Jun 07	Aug 08	Sep 10
Total	1262	1294	990	1080	1229	1237
Number of Observations	54	105	82	61	111	76
Number of Bulls	28	64	51	32	69	65
Average Herd Size	35	19	18	28	17	28
Bull:Breeding herd ratio	0.023	0.052	0.054	0.031	0.059	0.055
Median	21	12	10	17	13	18
Variance	56.539	20.290	26.894	28.344	12.863	23.948
Number of Breeding herds	35	65	53	38	69	42
Number of Bull groups	19	40	29	23	42	41

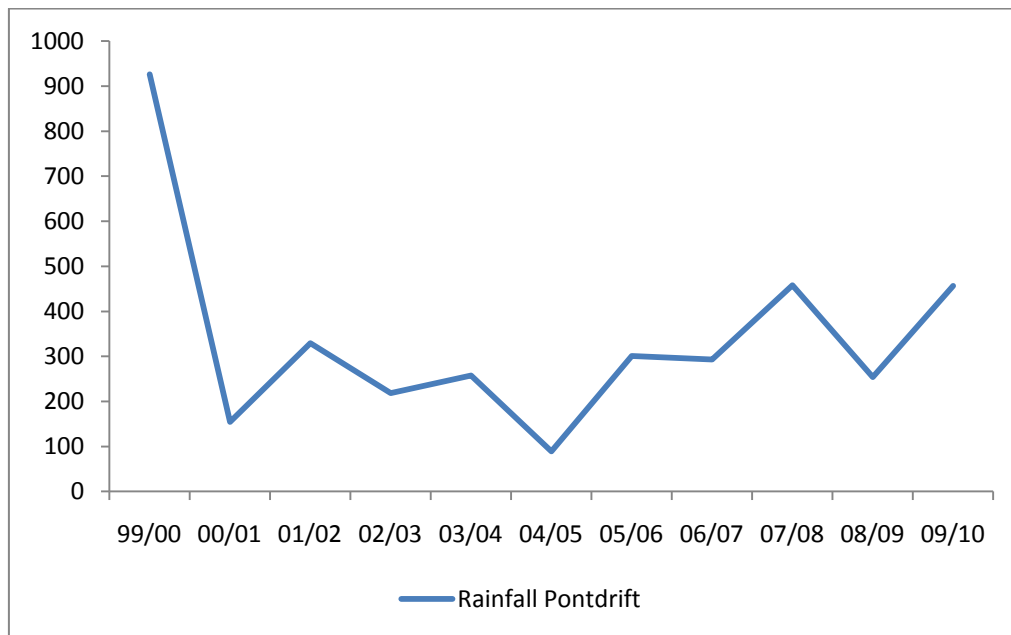


Figure 5: Seasonal rainfall for Pont Drift weather station for the seasons 99/00 to 09/10

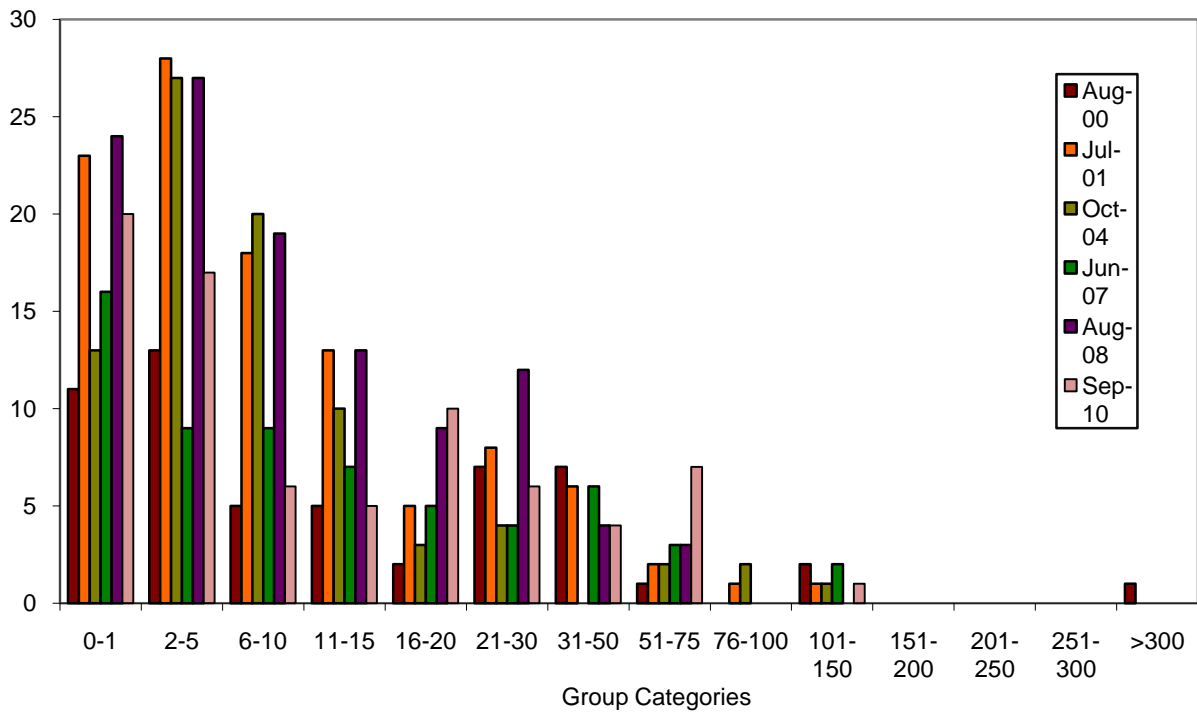


Figure 6: Comparison of group size distribution for the six total aerial counts of the Central Limpopo Valley Elephant population.

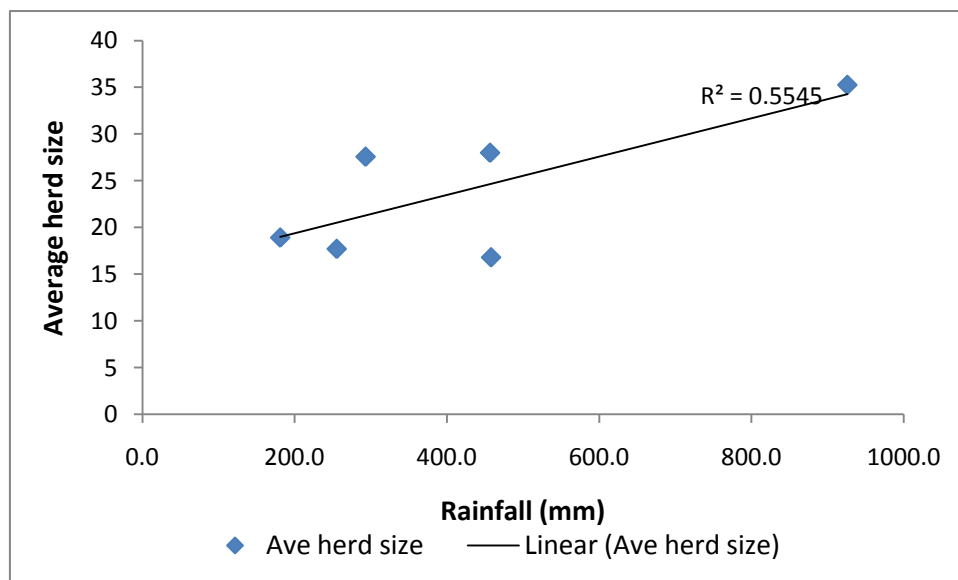


Figure 7: The relationship between average herd size of elephants in study area and rainfall in the previous 12 months.

Speculations on movements and dynamics

The data presented above suggests movement between the Sentinel – Nottingham area in Zimbabwe, Mapungubwe National Park (MNP) and the NTGR. However the high density of people in the Maramani area and the fence on the western boundary of Sentinel Ranch suggests that movement is probably along the Limpopo River or to the north of the fence. There are elephant pathways that enter the communal areas of Machuchuta, Masera, Maramani and River Ranch from the Sentinel-Nottingham Estate area, and residents reported crop raiding by elephants at night and return to the safety of the game farms in the early mornings. There appears also to be some movement to the northeast and east as in 2004 elephants were also observed moving back towards Nottingham Estate from the Zhove Dam (Ambler-Smith, pers. comm.)², and Patterson (1999) reports some 30 elephant recorded at Beitbridge. During the 2007 count no elephants were observed in the vicinity of Zhove Dam but elephant utilisation in the area was noted.

Even though several reports of elephants within MNP have been received all prior counts only recorded bulls within MNP. During the 2007, 2008 and 2010 counts several herds were recorded within MNP and mainly on Little Muck. The absence of elephants from the Tuli Circle Safari Area (TSA) during the 2001, 2004, 2007, 2008 and 2010 counts can probably be explained by disturbance from extensive hunting.

Movement of elephants from the NTGR and BDMRF into the communal areas of the Bobirwa within Botswana has been regularly reported. Elephants make use of the dry riverbeds as well as road crossings to gain access to the communal areas. Recently several reports on the presence of elephants have been received from as far as Zanzibar along the Tuli Block. During the 2010 elephant count this area was included in the count but no elephants were observed within this section of the Tuli Block. Signs of the presence of elephants however were noted.

During May 2008 a large herd of elephants were reported near Bobonong. During the 2007, 2008 and 2010 aerial counts no elephants were observed along any of the rivers within the communal area. Signs of the presence of elephants were however recorded along the Motloutse and Thune rivers.

During the 2004 aerial count a total 165 elephants were counted at Letsibogo dam. Since 2006, 14 elephants have been placed on the hunting quota for the Mmadinari Trust and another 20 elephants on the hunting quota for CT27, an area stretching from Martin's Drift to the Shashe River including the areas of Semolale and Terrafo (Sechele, pers. comm.)³. This could have an effect on the number of elephants counted in the area since the 2004 count.

It is suggested that the elephants move from Letsibogo dam to the confluence of the Shashe and Ramokgwabane rivers and further north along the Ramokgwabane River. Little sign of elephants were recorded along the Shashe River. For most part large herds of cattle and several new cattle posts along the Zimbabwean side of the Shashe River were observed. Patterson (1999) recorded elephant movement along the Shoshani, Simukwe and Tuli rivers.

² Ambler-Smith, C. November 2004. Manager Nottingham Estate, Zimbabwe. Personal communication.

³ Sechele, M. August 2007. Department of Wildlife and National Parks, Botswana. Personal communication.

The high density of people and livestock along this area makes the movement of elephants from the NTGR and TSA along the Shashe River to the Ramokgwabane River unlikely.

Critique of the Census Methods

Counting animals in wild populations is problematic wherever it is undertaken. There are always statistical issues that have to be addressed. The census conducted here suffers from the drawback that no estimates of the counting error can be made. There are always counting errors. Considering that it is also expensive and very time consuming particularly from an organisational perspective in obtaining permission to overfly three different countries, several agencies have suggested that a sample count be undertaken to replace the total count. Such an undertaking is however not straightforward. As the analysis presented above shows, the distribution of herds is strongly contagious in that elephants are associated with rivers. A sample survey would therefore require stratification of the sampling in areas away from and associated with rivers. Location of the boundaries of these areas would strongly influence the results, and it is not possible to accurately define where they should be.

In theory, a total count repeated at least twice, preferably three times in succession would provide estimates of the accuracy of the counts. However this would cost substantially more.

Concerning the 2008 count we know that there are around 150 elephants resident in the Letsibogo Dam area (though the numbers may have declined recently). Large areas of Zimbabwe were also not sampled this year, and the expectation is that more elephants might be found here. On the other hand the numbers in the Tuli Block west of NTGR have increased dramatically, suggesting that elephants may have moved there from the rest of the range. Alternatively, it is possible that there was an over count in this section. However, because flight paths are mapped, double counts are easy to detect when similar numbers are counted on adjacent flight paths, so this is not likely. Without at least one repeat count though, it is not possible to determine exactly what the confidence limits in the count are, nor is it possible to assess the stability of the population.

In order to reduce counting error in this year's count elephants observed were also photographed and the numbers counted were checked against the photographs taken. Minor errors were found in the counting data.

CONCLUSION

Elephant numbers counted within the Central Limpopo Valley during the six total aerial counts appear to be stable at between 1100-1300 elephants. No estimate of the accuracy of these counts is possible.

The distribution of the elephant population is mainly determined by the presence of humans and human activity, fences and large river systems. At least four distinct core areas can be identified for the mid to late winter period within the study areas suggesting the possibility of different clans or bond groups.

Group size distribution was different between the different aerial counts and can be correlated to the rainfall within the area. Higher rainfall seasons resulted in fewer but bigger groups while low rainfall seasons resulted in more but smaller group sizes.

Data from the six aerial counts suggest that the population within the Central Limpopo Valley at least for the winter months is stable. Movement of elephants between the NTGR, MNP, BDMRF, TSA and SNRC occurs. Movement of elephants from the NTGR and BDNRF to Letsibogo Dam is possible but unlikely. Elephants however do move into the communal areas within the Bobirwa sub district in Botswana. It is more likely that the elephant population utilising the Letsibogo Dam area is a separate subpopulation travelling to and from the Ramokgwabane River. The movements of this sub population are still unknown and it is suggested that two satellite collars be fitted to a herd and a single mature bull in order to track their movements. Movement out of the current study area following the Limpopo River in a westerly direction is likely. According to reports from farmers on the BDMRF elephant numbers have been steady increasing along the Limpopo riverine in this region and moving south to as far as Zanzibar. The sections between Baines Drift and Zanzibar have not been previously counted.

ACKNOWLEDGEMENTS



The Botswana Department of Wildlife and National Parks, the Zimbabwe National Parks and Wildlife Authority, Botswana DCA, Zimbabwean Defence Force, and the landowners within the Tuli Block are thanked for permission to conduct the survey. The following organisations sponsored the 2010 elephant count - Bateleurs, Peace Park Foundation, Northern Tuli Game Farmers Association, Mashatu Game Reserve, Tuli Lodge and South African National Parks Board. A word of thanks to Tuli Lodge for accommodating participants in the aerial count, Pete le Roux for sourcing and collecting AVGAS for the aerial count, Russell Taylor for his assistance on the Zimbabwean side, Nick Hiltermann for his organisation, Dennis Summers and his airfield team for always being ready and waiting to help with the refuelling of the planes. A special word of thanks to Raymond Steyn, Tim Webster and Avroy Shlain for their superb flying, Cathy Greaver (SANParks) for assisting with the computer program

and navigating, Bruce Page for all his help, all the counters for their assistance and time and Nick Hiltermann for being able to use his photographs.

REFERENCES

FEELY, J.M. 1975. *Towards a plan for the Eastern Tuli Block, Botswana*. Report to the Eastern Tuli Game Protection and Conservation Association. Wilderness Leadership School, Bellair. 31pages.

HALL-MARTIN, A.J. 1987. *Mashatu Game Reserve and the Conservation of Tuli Elephants*. Report to NOTUGRE. 11 pages.

NCHUNGA, M.L. 1978. A study of the potential for the commercial use of wildlife in North Eastern Tuli Block. MSc Thesis, Texas A & M University, Texas USA.

PATTERSON, G. 1999. Exploration into the existence of elephant movement corridors – Tuli / ZimBotSA elephant population. Report to the Department of Wildlife and Tourism, Botswana. 43 pages.

PAGE, B.R. 1980. Elephant carrying capacities in the Tuli Block, Botswana, based on an assessment of their impact on woody vegetation. Progress report to the Endangered Wildlife Trust.

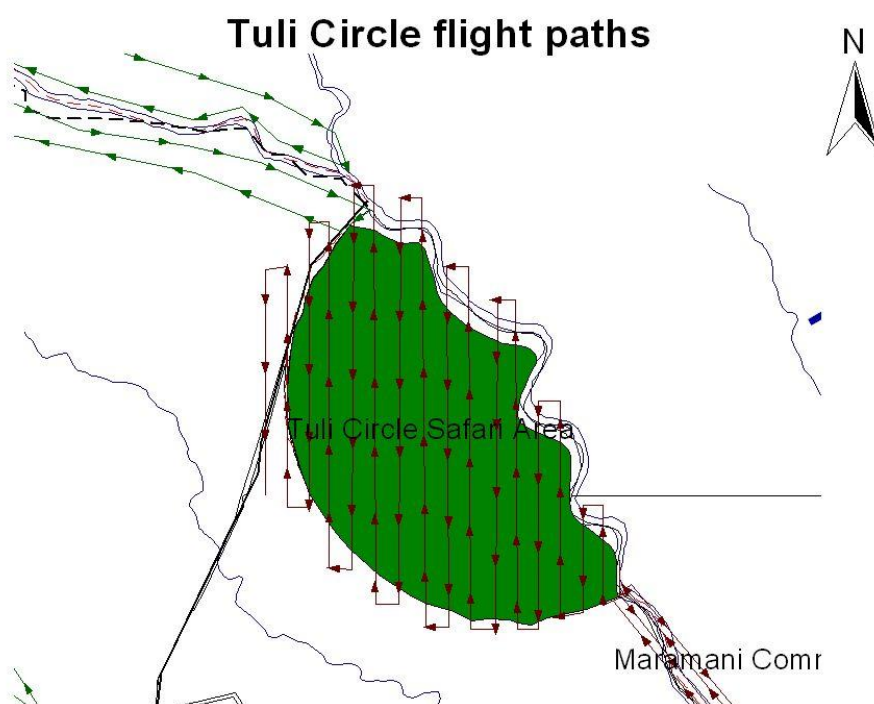
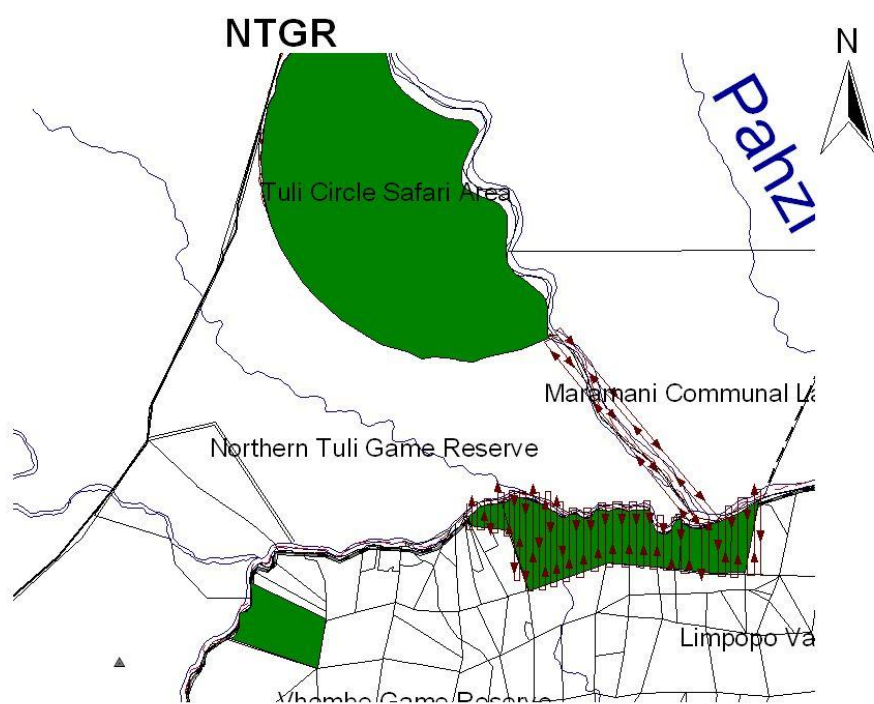
PAGE, B.R. 1990. Some ideas on management and monitoring in the Northern Tuli Conservation Area, Botswana. Report to the Landholders in the Northern Tuli Conservation Area.

SPINAGE, C.A. 1990. Botswana's Problem Elephants. *Pachyderm* 13: 16-21.

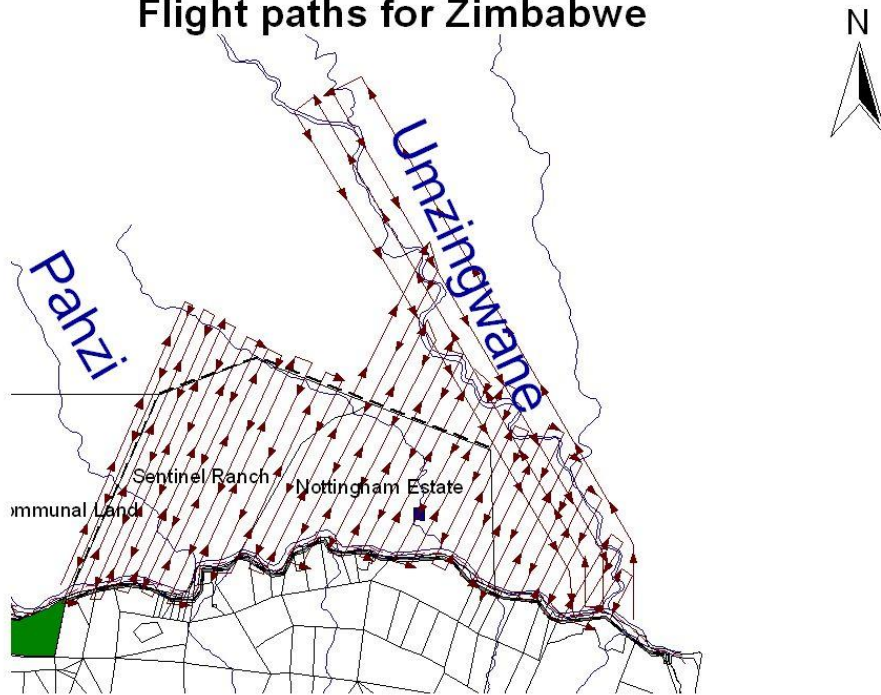
WALKER, C. 1971. Elephants of Tuli. *African Wildlife* 31(5): 6-9.



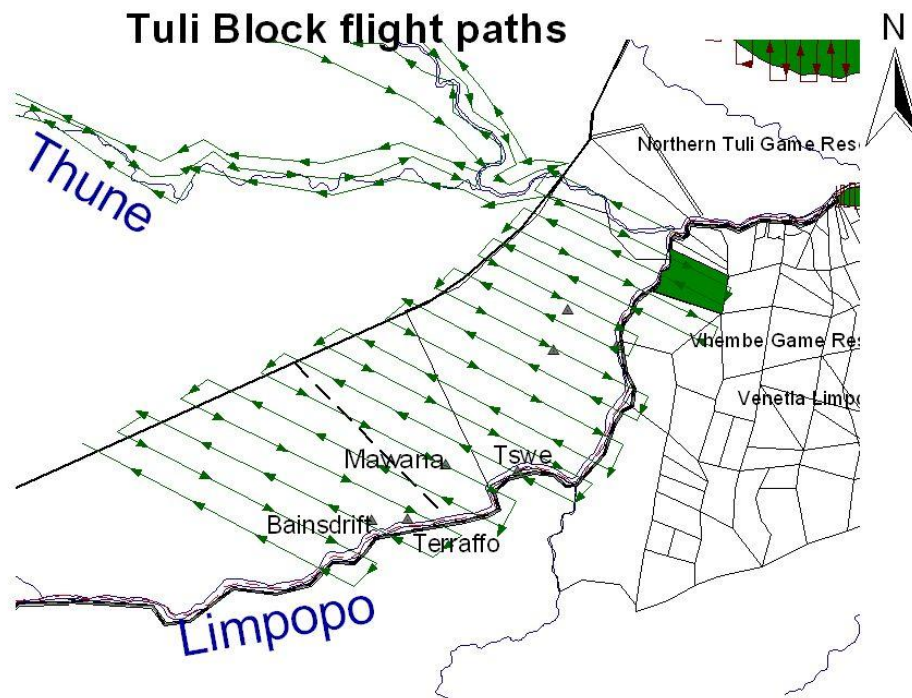
APPENDIX A



Flight paths for Zimbabwe



Tuli Block flight paths



APPENDIX B

Budget in Rand

	Unit	Total ®	
AVGAS/plane @ R18.00/L)	200L Drums		
Cessna 206 ZS-PIL	5	18000.00	Sponsored by Northern Tuli Game Reserve
C182T ZS-COM	2.5	9000.00	Sponsored by Bateleurs
C182T -	3.5	12600.00	Sponsored by Bateleurs
Transport Cost for fuel to LVA		0.00	Sponsored by Mashatu Game Reserve
	11	39600.00	
Accommodation (per person per night)	(P100/p/night)		
3 Pilots for 4 nights	120.00	1440.00	
3 Navigators for 4 nights	120.00	1440.00	
6 Counters for 4 nights	120.00	2880.00	
		5760.00	Sponsored by Peace Park Foundation
Navigation			
Cybertracker	1	0.00	Sponsored by SANParks
TOTAL		45360.00	