AERIAL WILDLIFE CENSUS OF THE CAPRIVI RIVER SYSTEMS
A SURVEY OF RIVERS, WETLANDS AND FLOODPLAINS
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EXECUTIVE SUMMARY

This report presents the results of an aerial wildlife census of the Caprivi River systems in Namibia conducted during September 2007. The purpose of this survey was to provide recent information on the distribution and abundance of wildlife species relative to protected areas and conservancies. The report compares the results of the September 2007 (Sept07) aerial survey to an earlier survey conducted in August 2004 (Aug04). Maps and tables illustrating the distribution and abundance of wildlife species in various land use categories are presented.

Wildlife numbers were highest in, or bordering conservation areas. A total of 17,050 head of wildlife was observed during the aerial survey. For wetland species hippo occurred in the greatest numbers (1,269), further we recorded 1,924 pelicans, which were concentrated alongside 10 km of the Chobe River. For woodland species, buffalo occurred in the highest numbers (5,951) followed by elephants (3,062). Wildlife numbers near the river systems of the Caprivi have increased between the two surveys. Our Sept07 survey observed 79% more wildlife observations than a survey conducted in Aug04. The rise in wildlife numbers both within the protected and conservancy areas may be attributed to the seasonal dispersal of wildlife within the Caprivi and movements between Botswana and the Caprivi. Further, conservation projects within conservancies encourage increasing wildlife numbers.

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AERIAL WILDLIFE CENSUS OF THE CAPRIVI RIVER SYSTEMS
A SURVEY OF RIVERS, WETLANDS AND FLOODPLAINS

Introduction

The first comprehensive wildlife aerial census of the Caprivi River systems in Namibia was conducted in August 2004 (Aug04). The aerial surveys focus on the Kavango, Kwando, Linyanti, Chobe and Zambezi rivers and their associated wetlands and floodplains. Hippo and crocodile as well as floodplain ungulates including reedbuck, lechwe, waterbuck, puku and sitatunga were counted. Other wildlife species and wetland birds (cranes and pelicans) were also included in the count.

This report presents the results of the second river systems survey, which was flown in September 2007 and compares these survey results with a similar aerial survey flown in Aug04. These surveys, funded through the Namibia Nature Foundation and Ministry of Environment & Tourism (through the ICEMA project) will provide resource managers in the region with recent information for evaluating the trend in wildlife species associated with rivers, wetlands and floodplains. The surveys offer the opportunity to monitor wildlife distribution and abundance between protected areas and conservancies, and compare changes over time. This provides both the park and conservancies with an important set of information to help them adaptively manage wildlife populations. The survey also builds on a co-management approach which recognizes that local level management (conservancies, parks, community forests) is strengthened by conservation monitoring approaches which cross management authority boundaries and which set higher order goals and objectives which are best achieved through collaboration. The conservancies may never carry the same biomass of wildlife as protected areas, but they do aspire to support a larger biomass and diversity than at present. Conservancies are a critical part of the landscape and which provide linkages and corridors for wildlife movement. At a larger scale the surveys will contribute important data to a number of current conservation initiatives such as the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA), community conservation programmes and wildlife management in protected and conservancy areas.

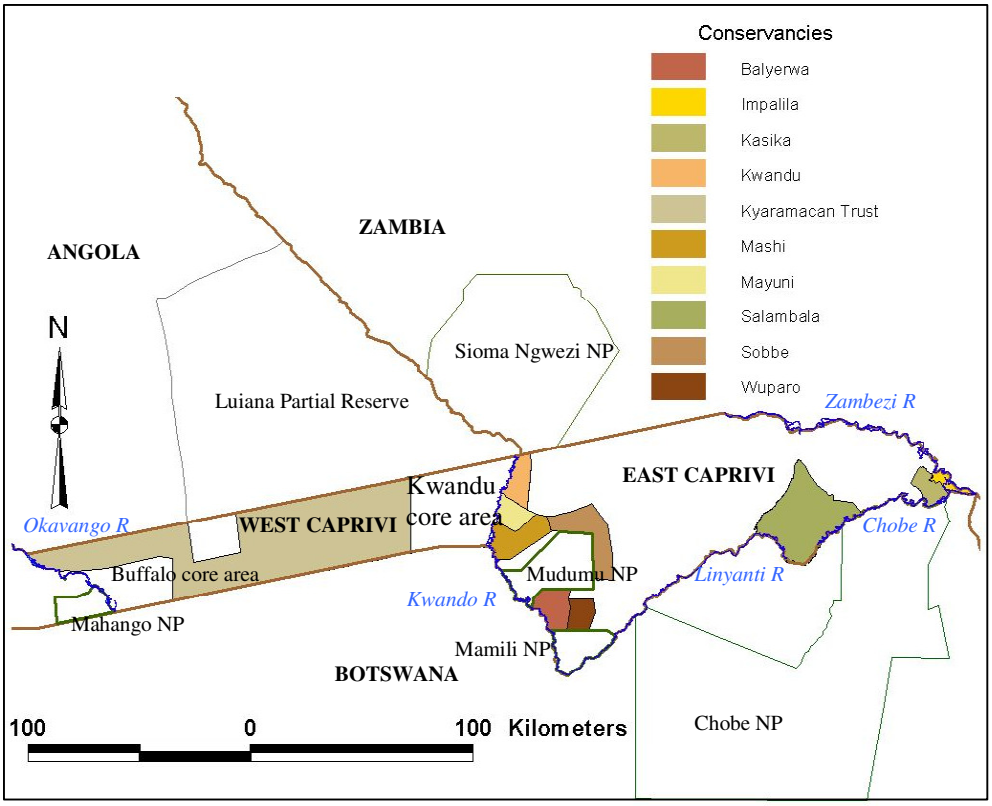
Study Area

The Caprivi region of Namibia (~18,000 km^2) is surrounded by Angola, Botswana, Zambia, and Zimbabwe, lying between the Okavango River in the west, and the Zambezi and Chobe rivers in the east. The Okavango, Kwando, Linyanti and Zambezi rivers provide perennial water. There are extensive, broad floodplains that flood seasonally along these rivers and smaller, permanent wetlands occur within these floodplains.

The Kwando River separates the East and West Caprivi. Our survey along the major rivers in the West Caprivi included the proposed Bwabwata National Park (NP) along the west side of the Kwando River (94 km^2 and referred to as Susuwe in this report). Our survey along the Okavango River also included parts of the Buffalo NP and the small Mahango NP (48 km^2, and referred to as Mahango/Buffalo) (Figure 1). In the East Caprivi,

our survey of the Kwando River included Mudumu NP (65 km^2), Mamili NP (377 km^2), and four conservancies (Kwandu, Mayuni, Mashi, Balyerwa), all of which are on the east side of the Kwando River. The conservancies of Salambala, Kasika and Impalila were also included and which adjoin the Linyanti and Chobe rivers respectively (Figure 1).

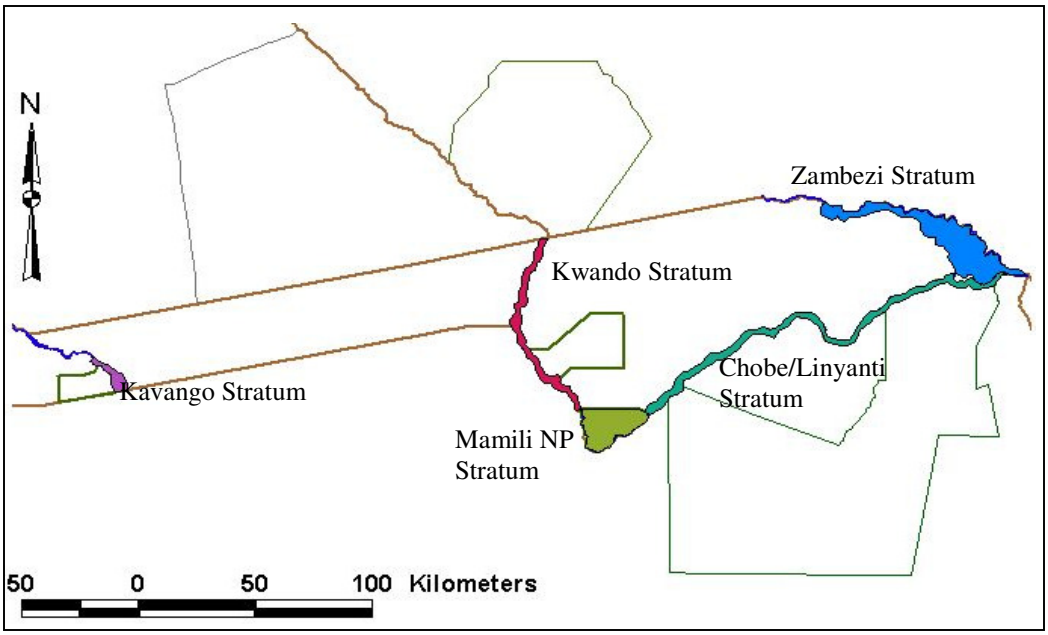
Figure 1. Conservancies and National Parks (NP) in the Caprivi Strip, Namibia



Methods

The aerial survey was flown over 11 days between 29 August and 21 September 2007 when we expected increased visibility and wildlife to be aggregated near the perennial rivers. Similar to the strata used by Stander (2004), we delineated our survey area into five strata which included, Kavango (56 km^2), Kwando (370 km^2), Mamili NP (377 km^2), Chobe /Linyanti (520 km^2) and Zambezi (455 km^2) (Figure 2). Within each stratum we delineated areas according to protected area or conservancies to provide species counts for the respective areas (Figure 1).

Figure 2. Layout of five strata for Caprivi River Systems survey.



For our survey, we used the methodology of the MET (2004) survey. We attached two wands to each of the wing struts to delineate a 250 m interval for recording wildlife observations at an altitude of 90 m. The survey was flown by means of a total count. We spaced transects 500 m apart, providing a 100% sampling coverage. We typically flew transects during morning hours (~0730 - ~1030 hrs); however, the Kavango stratum was flown between ~1600 - ~1730 hrs due to logistical constraints on 29 August 2007.

Interval widths on each side of the plane were calibrated and confirmed prior to initiating each survey by placing markers at measured distances on the airstrip and conducting flyover tests. After repeated flyovers and photo verification, wands were adjusted to provide the designated interval widths at appropriate flight altitude. The aluminum wands were semi-permanently attached to the struts for the duration of each survey.

Transects were flown at 100 knots using a Cessna single engine plane, and altitude was maintained using a radar altimeter. Flight transects were systematically flown along generally east/west axes, corresponding to the perpendicular gradient of major watercourses. For logistical reasons, we flew the eastern half of Mamili NP in a north-south orientation.

Prior to flying, all transects were incorporated into a digital map of the survey area with their beginning and end point coordinates. This digital map was created using ArcView 3.2 (ESRI 2002) software and showed observable landmarks and boundaries. All transects were mapped as routes prior to flying and shown on the digital map with their beginning and end point coordinates. We used GPS receivers (Garmin 12xl, Garmin 176c)

and DNR Garmin software (Minnesota Department of Natural Resources, GIS Section) to navigate along transects.

For all strata we used the standard methodology for transect sampling developed by Norton-Griffiths (1978), only wildlife observations that were observed within the interval were counted and recorded. For the Chobe stratum the flight path was restricted to the river and adjacent floodplains and observers recorded wildlife species inside and outside the counting interval (Stander 2004). Observers recorded herds when they were as nearly perpendicular to the plane as possible. Additionally, a mark was put on the plane window to help observers keep their eyes at a consistent height to maintain the same sighting angle for each observation. This helped us to keep consistent interval widths for each observation. Any animals outside of the area delineated by these wands were not counted. For each observation seen within the transect interval, the observer called out the numbers of species. With each herd observation, a data recorder entered a waypoint on the GPS. The recorder also kept a written data log for each observation including: the waypoint number and time, altitude from the radar altimeter, and number of individuals observed. The start and end times for each transect were also recorded. The same two observers were used throughout the survey, one on each side of the plane. Both of the observers had extensive previous aerial survey experience (> 950 hrs) prior to this project.

To verify herd size and the sighting of herds within the interval defined by the wands, two cameras were used. The components of the camera system consisted of two cameras with 20-mm wide-angle lenses, camera backs with time code generators, and two window camera mounts. A camera was mounted on each side of the plane and the center of the lenses corresponded with the marks on the plane window that were used to help observers keep their eyes at a consistent height for each observation. The cameras provided high-resolution photos so that animals could be more accurately counted during subsequent analyses. Typically, observers took a picture with each wildlife observation. A GPS time code and date were recorded to the second for every frame exposed.

Data Analyses

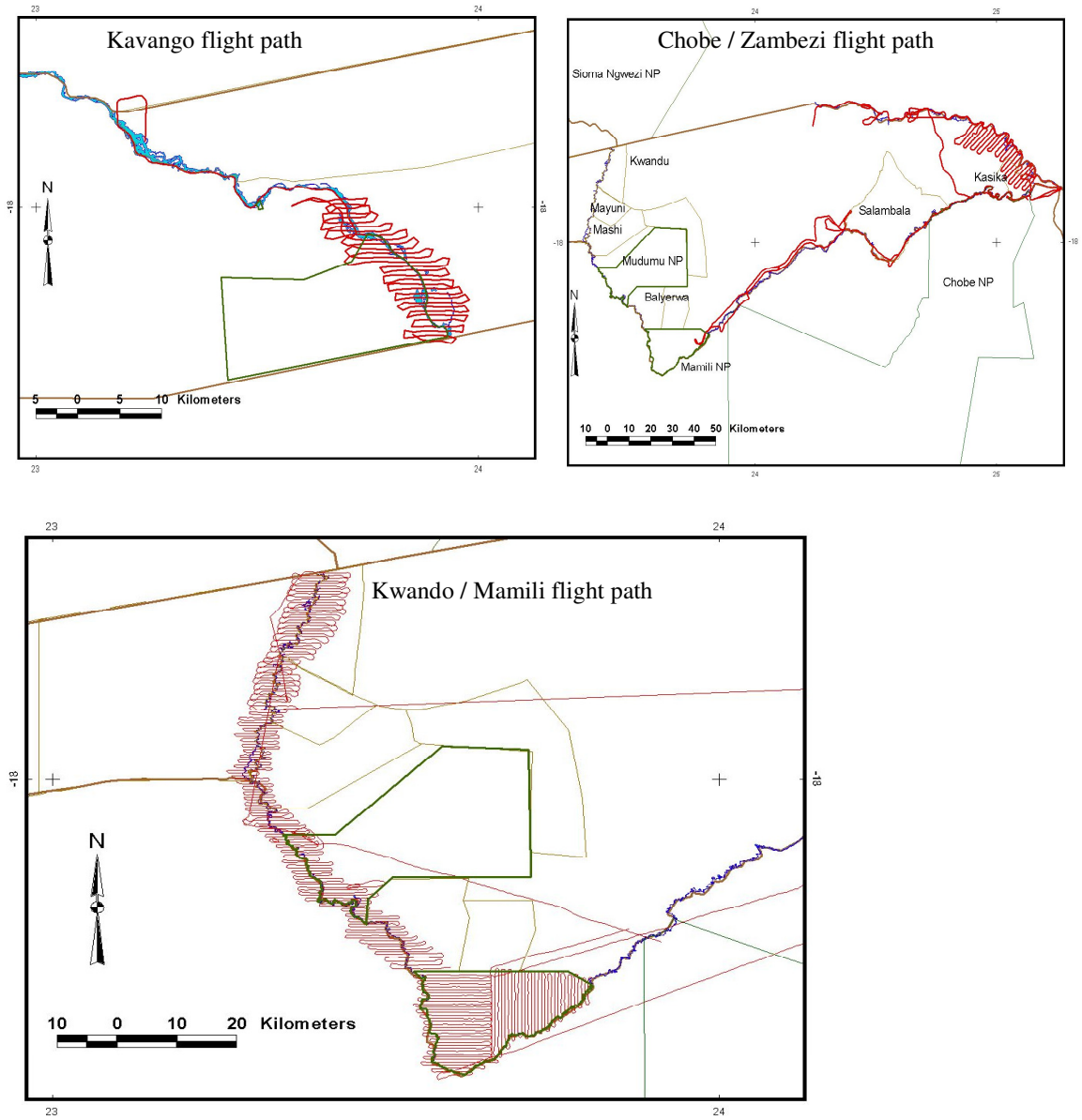
Photo-Interpretation. The number of individuals in the digital image of each herd was counted and compared to the observers' counts. This method verified and/or corrected observers' herd counts and determined whether animals occurred within the counting interval. This method was especially helpful in counting large herds that are difficult to count from the air.

Total Count. The entire area was covered in adjoining transects which were 500m apart, and the total number of animals counted is the total population for the counting area.

Results

For the 1,778 km^2 survey area, 42 hours were flown totaling 3,693 km (Figure 3). Flight altitude averaged 92 m (range 85-112 m) for wildlife observations. We counted a total of 17,050 animals, the highest numbers (7,037) occurred in the Linyanti / Chobe stratum, while the lowest numbers occurred in the Zambezi stratum (473). The most abundant species were buffalo (5,951) and elephant (3,062).

Figure 3. Recorded track log of flight paths during the survey.



Wildlife Distribution

During the Sept07, we observed more species distributed in the conservancies than on the Aug04 survey. While the total number of hippo observed between the Aug04 and Sept07 survey are similar (1,387 and 1,269 respectively). During our Sept07 survey we saw almost half the number of hippo in the Chobe/Linyanti and Mamili strata. Hippo numbers have increased in Kwando and Kavango strata by 26% and 42% respectively. The greatest number of hippo observed on the Aug04 survey occurred in Mamili NP (560), while on the Sept07 survey the largest number of hippo were observed in the Kwando stratum (389).

Wildlife numbers occurred in greater densities in the conservancies during the Sept07 survey than in the Aug04 survey (Figure 4). Hippos have increased in the conservancies by 32%, however the distribution of hippos in the conservancies varies between the two aerial surveys. On our aerial survey we observed no hippo in Mayuni, while on the Aug04 survey 42 hippo were recorded. In all the other conservancies hippo numbers increased with the greatest number being observed in Impalila (33) (Figure 5).

Lechwe in the protected areas and conservancies have increased by 13% and 48% respectively. The only decrease in lechwe numbers in the conservancies occurred in Mayuni. On the west side of the Kwando River, in the protected area, lechwe occurred in greater numbers (Figure 6). On the Au04 survey one reedbuck was observed in the Mashi conservancy, while on the Sept07 survey we observed 21 reedbuck in three conservancies (Table 3, Figure 7). Crocodile numbers in the protected areas and conservancies have increased by 44% and 130% respectively between the two surveys. Crocodile were widely distributed in the Chobe and Zambezi floodplains away from the main river channel (Figure 8).

The Sept07 survey indicates that water and floodplain species have increased their distribution considerably in the Kwandu conservancy. Buffalo along the Kavango and Kwando rivers occurred in protected areas. However, along the Chobe River they occurred in the Kasika and Impalila conservancies (Figure 8). The Aug04 survey recorded few observation of elephants along the Zambezi River, while on the Sept07 survey, elephants increased their distribution widely on the Kasika floodplains and adjacent to the river (Figure 9). Zebra are distributed extensively along the Linyanti and Chobe floodplains and occur in great numbers in the Salambala conservancy (Figure 11).

For the Kavango stratum, many of our wildlife observations were confined to the protected areas of Mahango and the Buffalo area of West Caprivi. While we extended the survey area north of the protected areas along the Kavango River to the Angolan border we only observed 3 pods of hippo and 1 crocodile north of the protected areas (Figures 14 - 19). The Kavango River north of the tar road and protected areas have the potential to support greater densities of wildlife. There is a 15 km band of river frontage south of the Angola border and along the eastern banks of the river, which is relatively undisturbed. Priority should be given towards encouraging wildlife conservation projects along the east side of the river.

Figure 4. Wildlife sightings in relation to conservancies and protected areas.

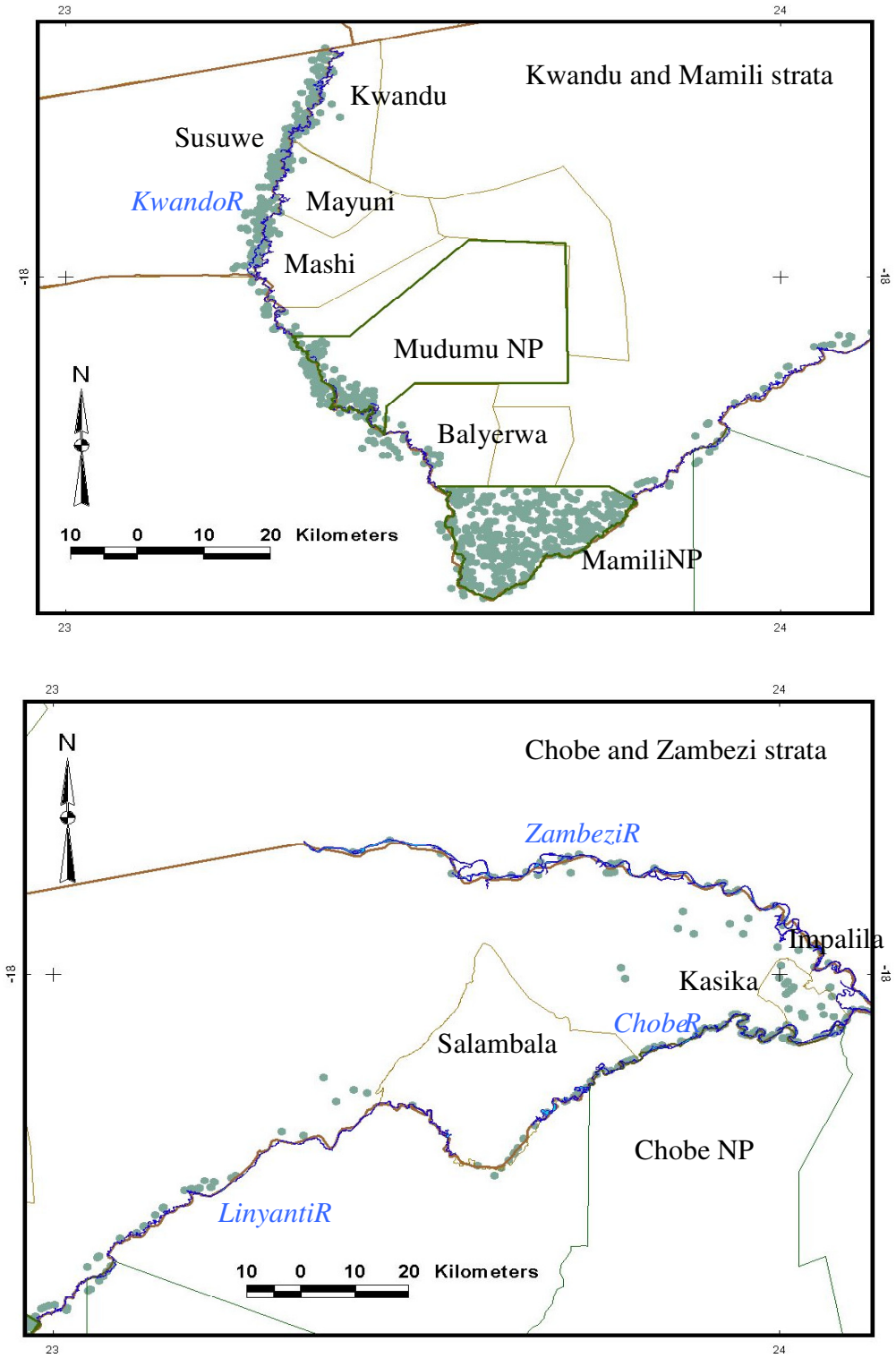


Figure 5. Distribution of hippo during aerial survey of Caprivi river systems, Sept07.

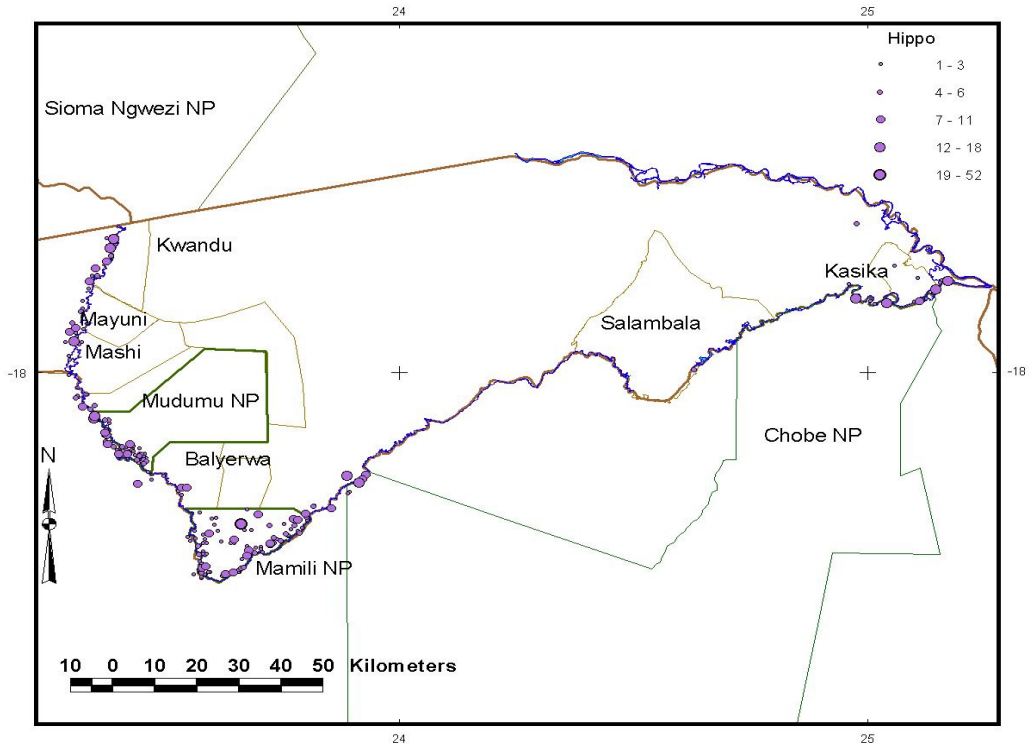


Figure 6. Distribution of lechwe during aerial survey of Caprivi river systems, Sept07.

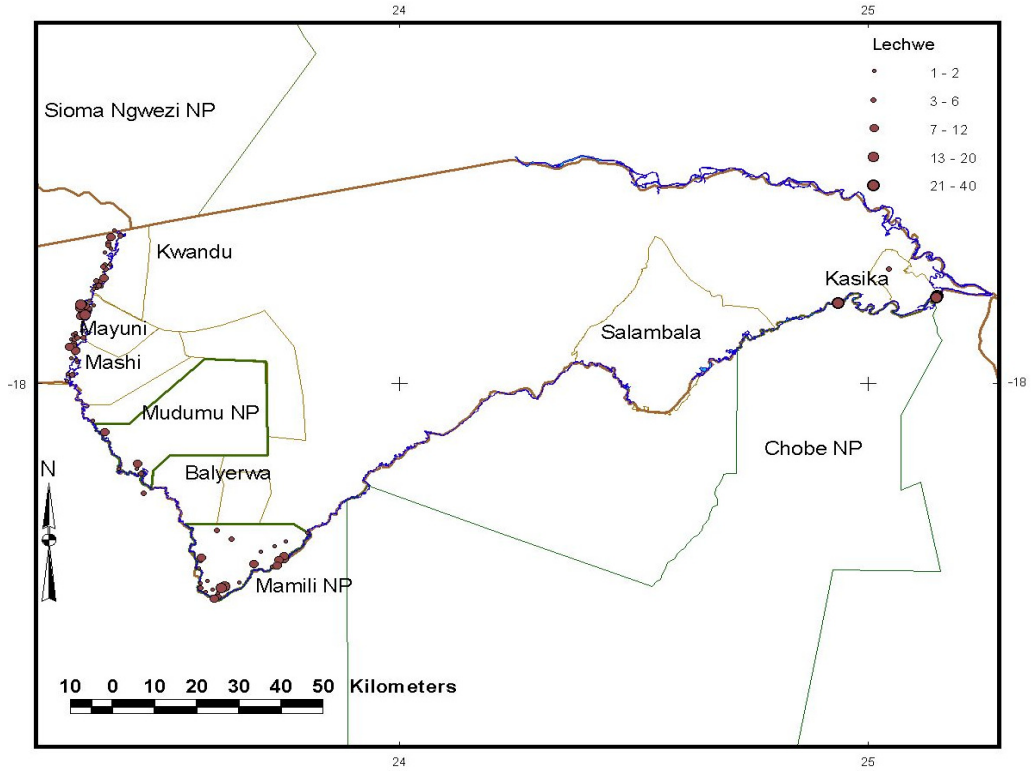


Figure 7. Distribution of reedbuck during aerial survey of Caprivi river systems, Sept07.

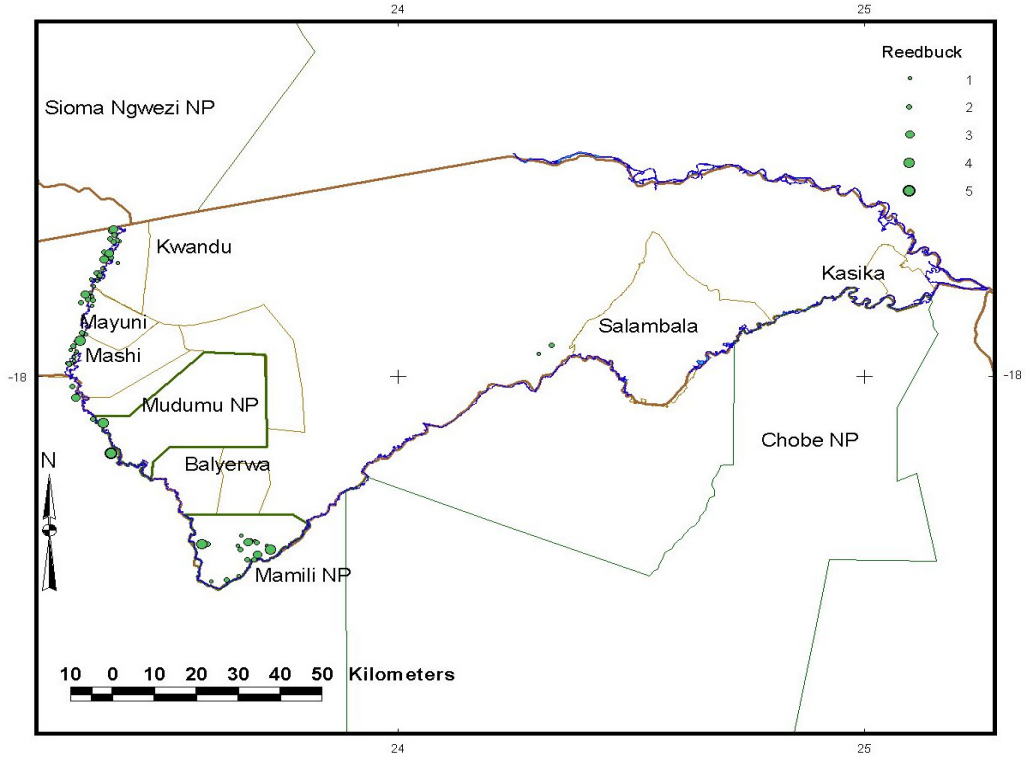


Figure 8. Distribution of crocodile during aerial survey of Caprivi river systems, Sept07.

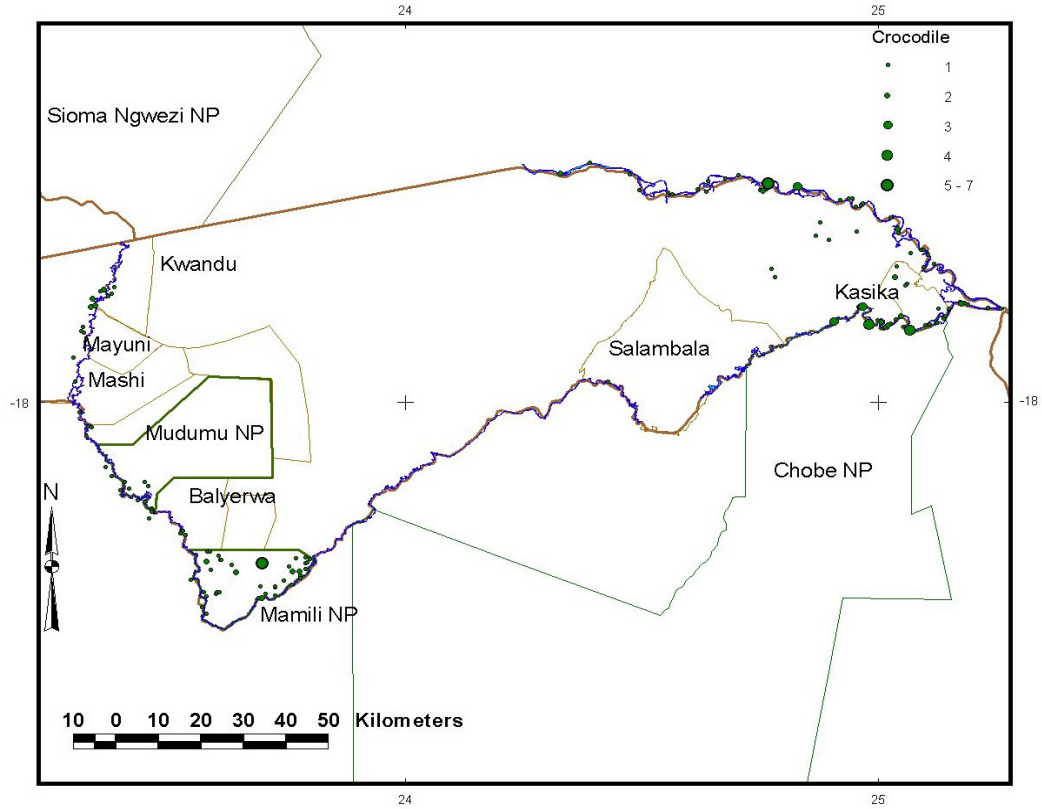


Figure 9. Distribution of buffalo during aerial survey of Caprivi river systems, Sept07.

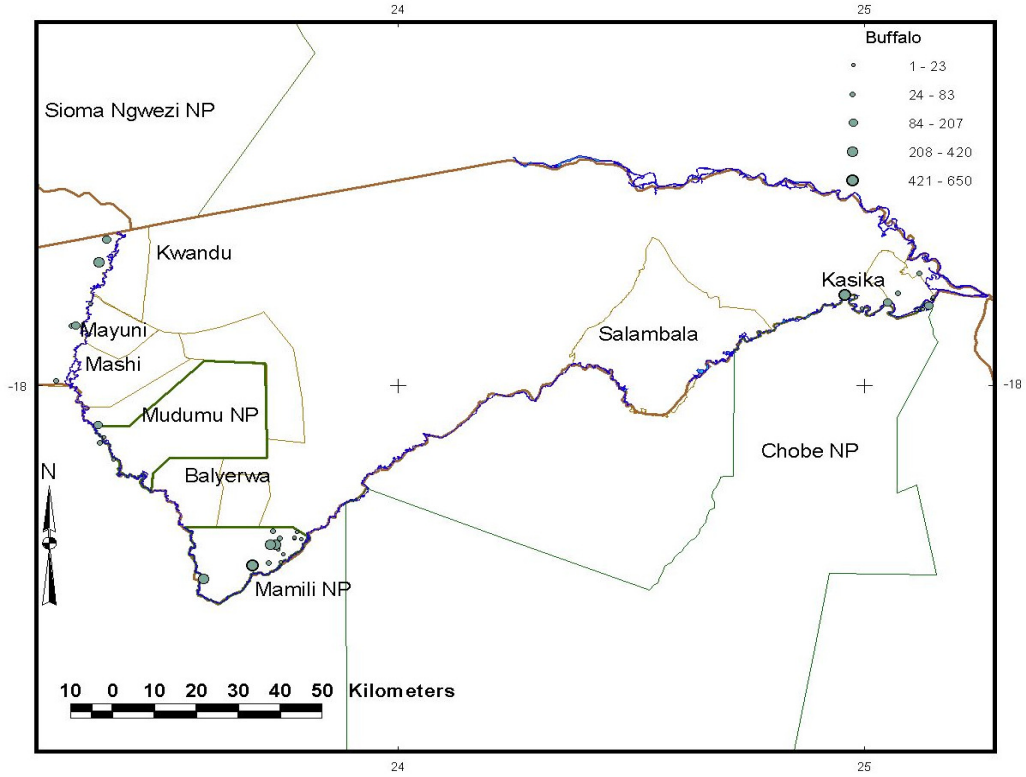


Figure 10. Distribution of elephant during aerial survey of Caprivi river systems, Sept07.

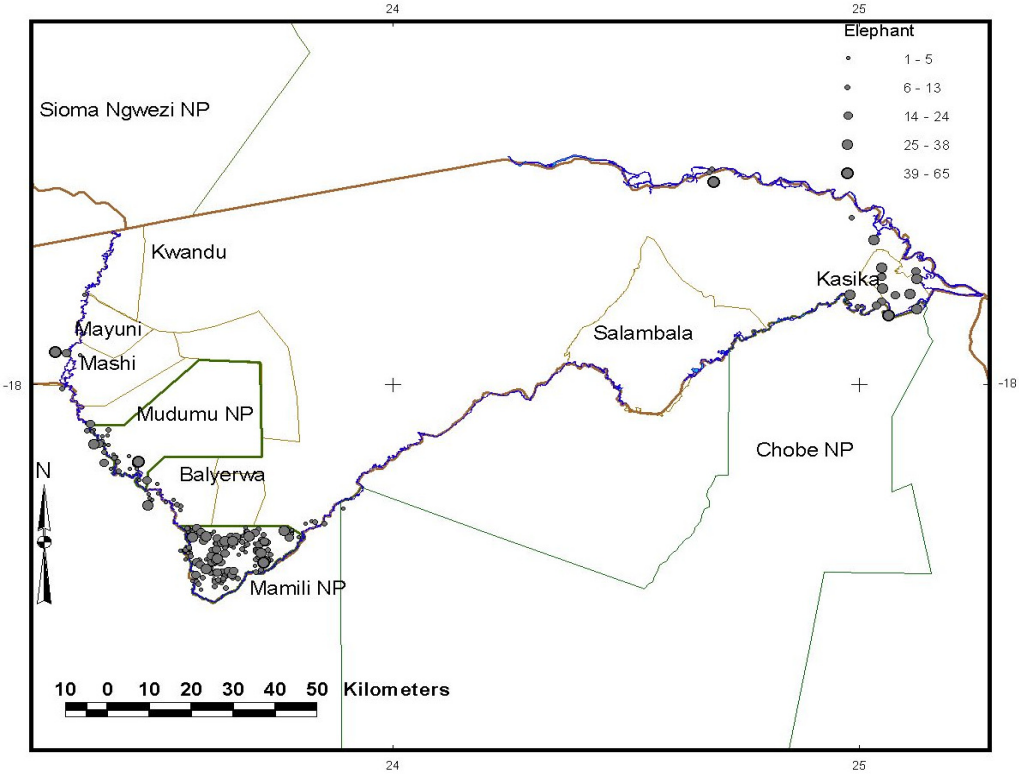


Figure 11. Distribution of impala during aerial survey of Caprivi river systems, Sept07.

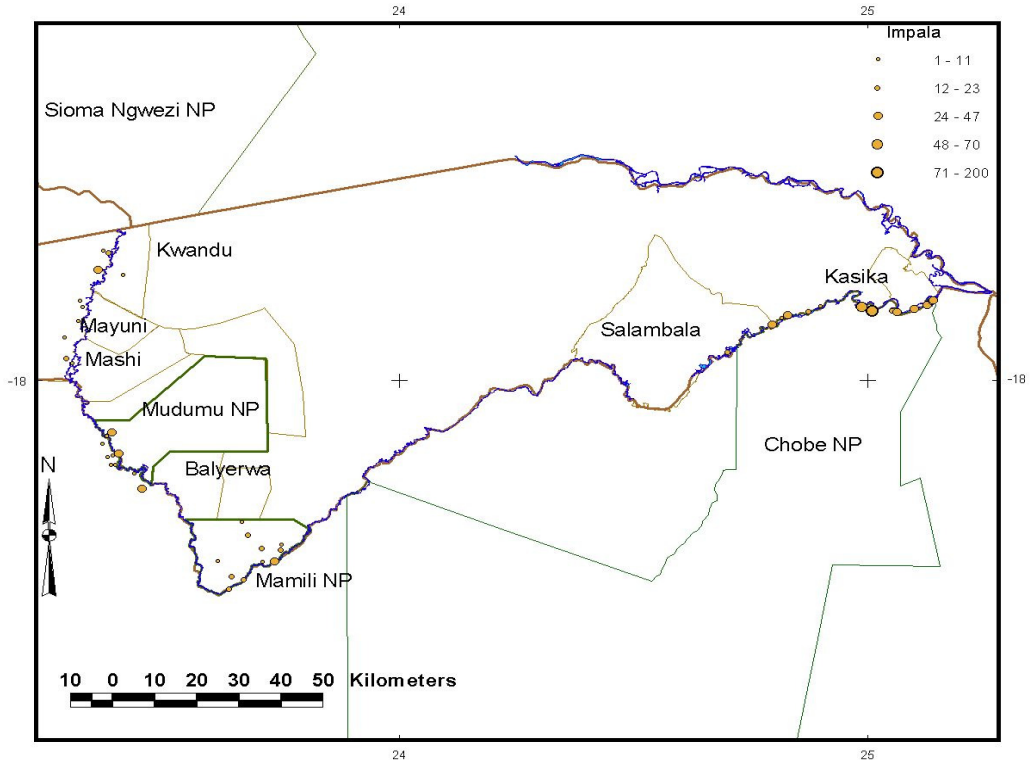


Figure 12. Distribution of zebra during aerial survey of Caprivi river systems, Sept07.

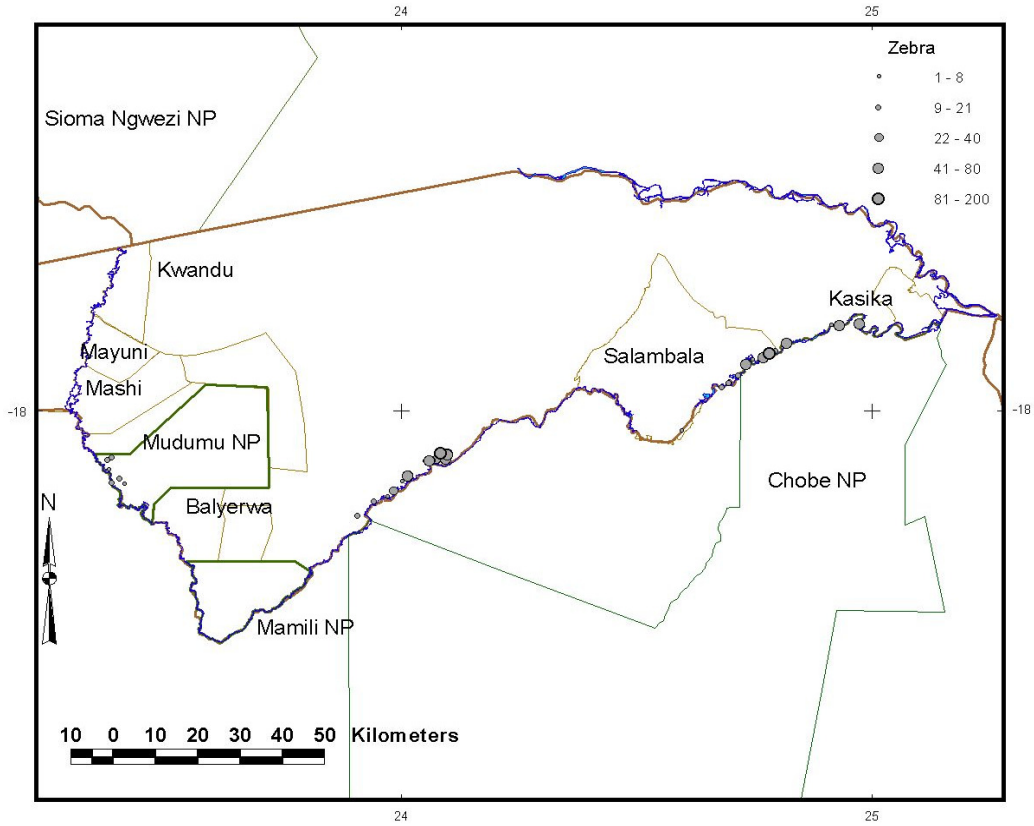


Figure 13. Distribution of wildlife during aerial survey of Caprivi river systems, Sept07.

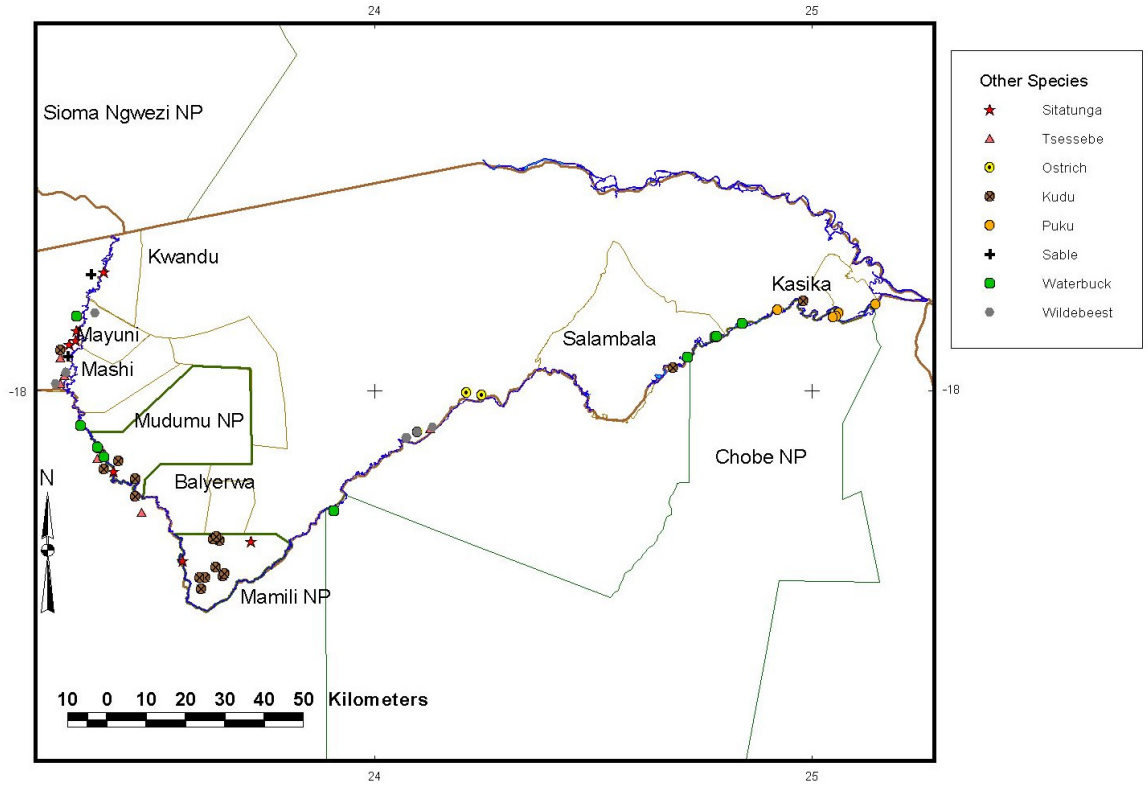


Figure 14. Distribution of wattled crane during aerial survey of Caprivi river systems, Sept07.

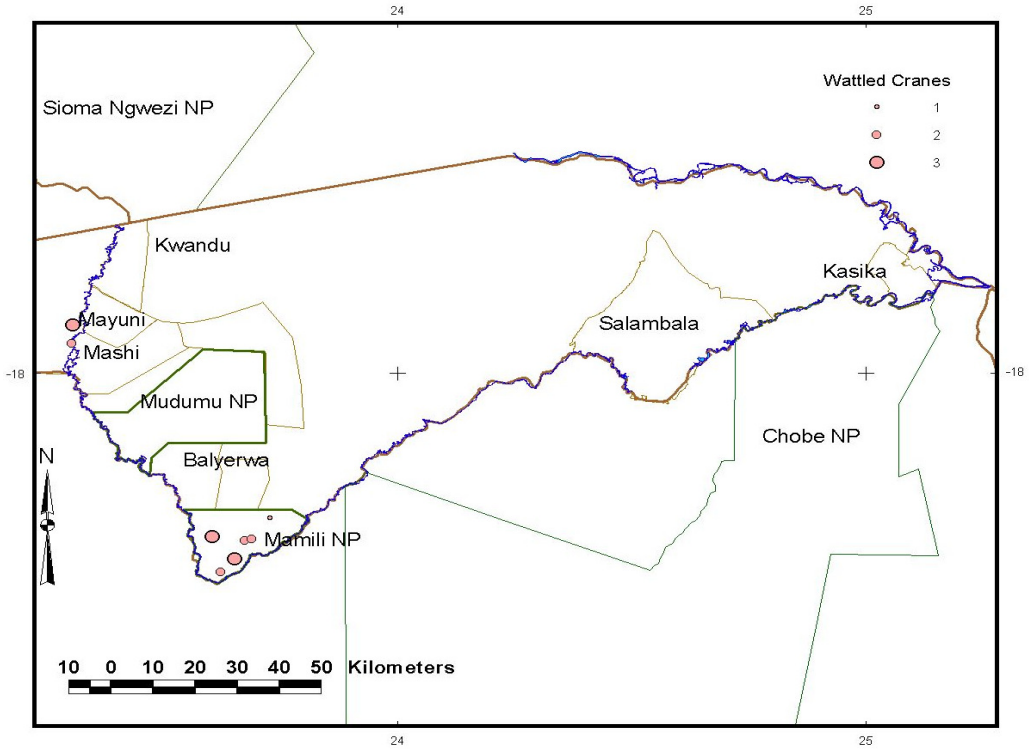


Figure 15. Distribution of hippo during aerial survey of Kavango River, Sept07.

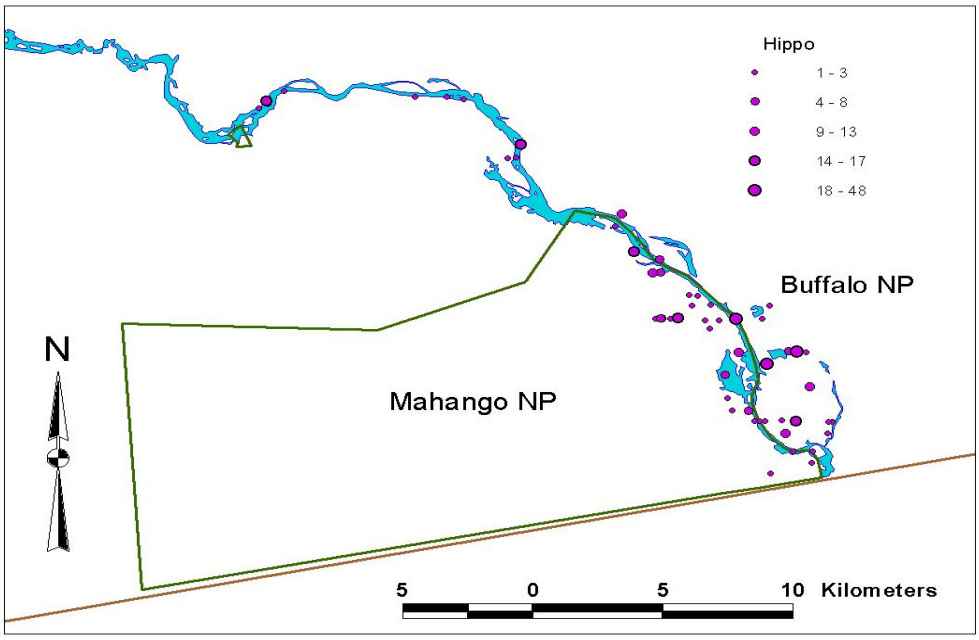


Figure 16. Distribution of crocodile during aerial survey of Kavango River, Sept07.

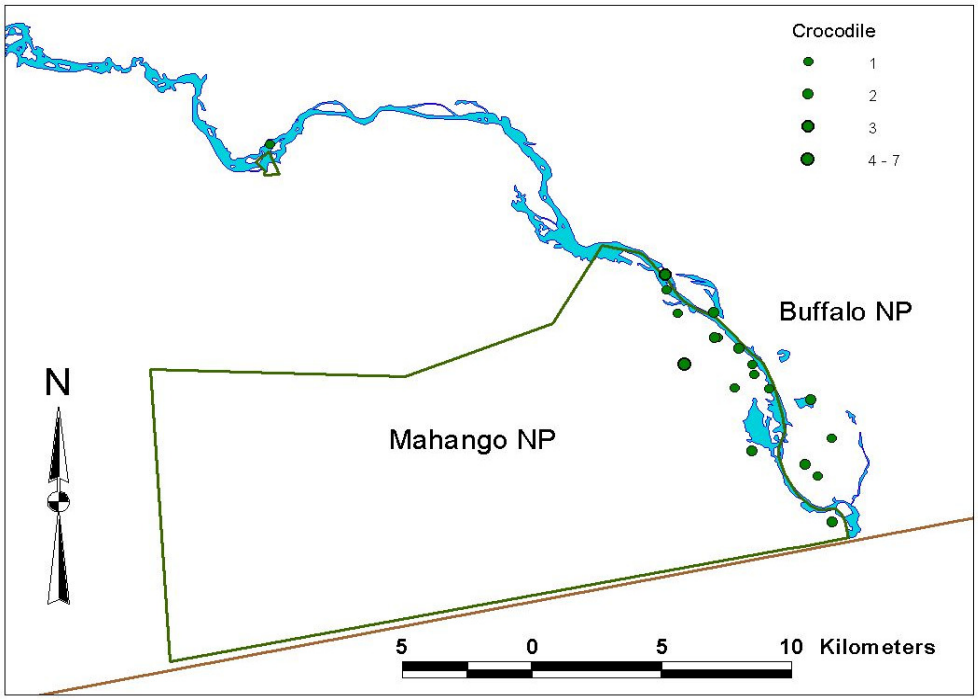


Figure 17. Distribution of lechwe during aerial survey of Kavango River, Sept07.

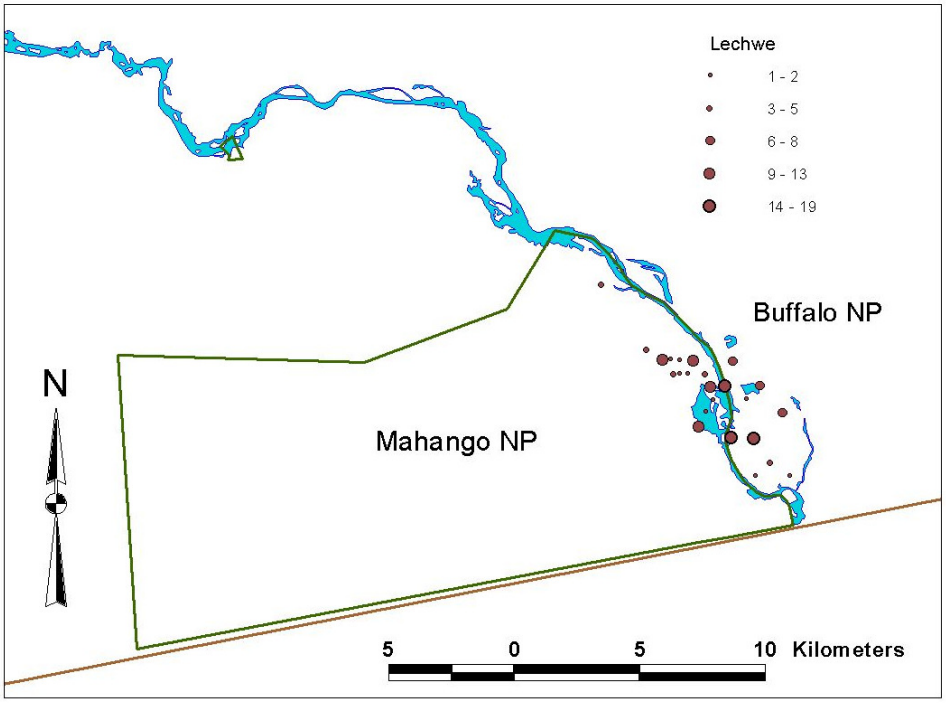


Figure 18. Distribution of reedbuck during aerial survey of Kavango River, Sept07.

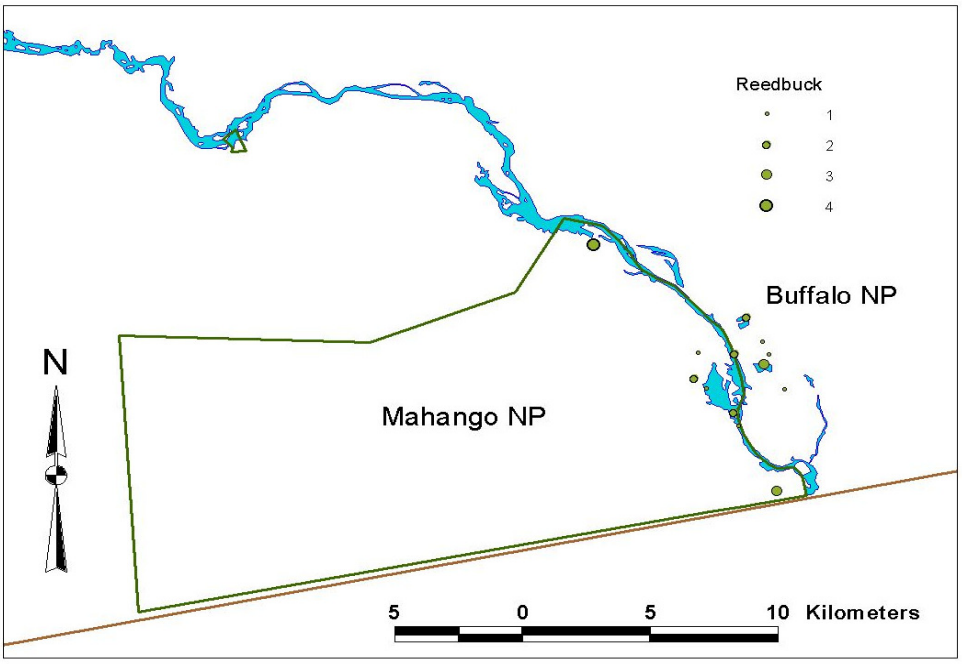


Figure 19. Distribution of buffalo during aerial survey of Kavango River, Sept07.

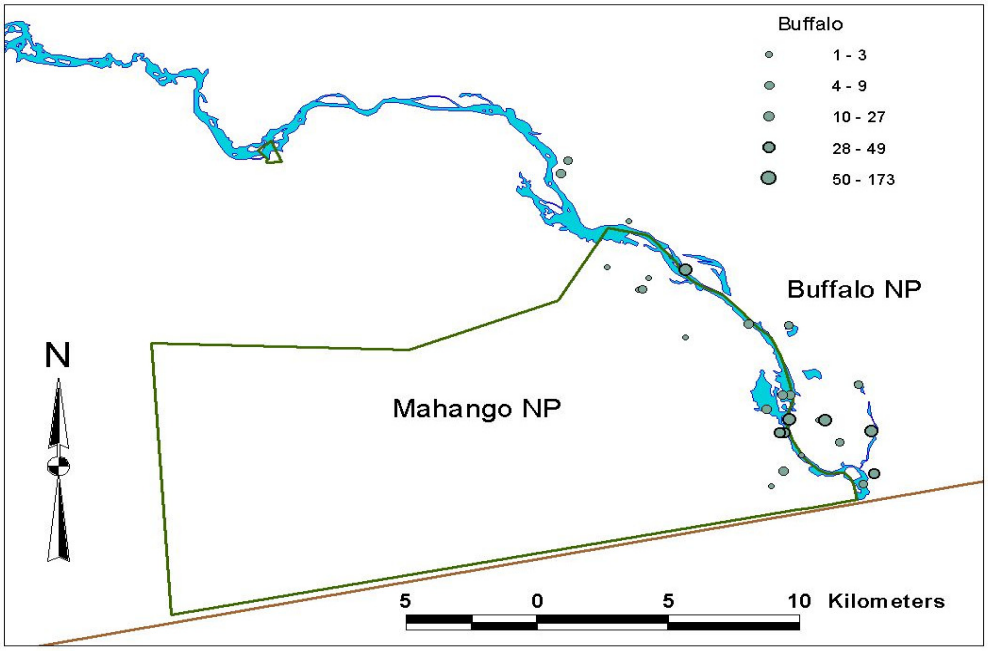
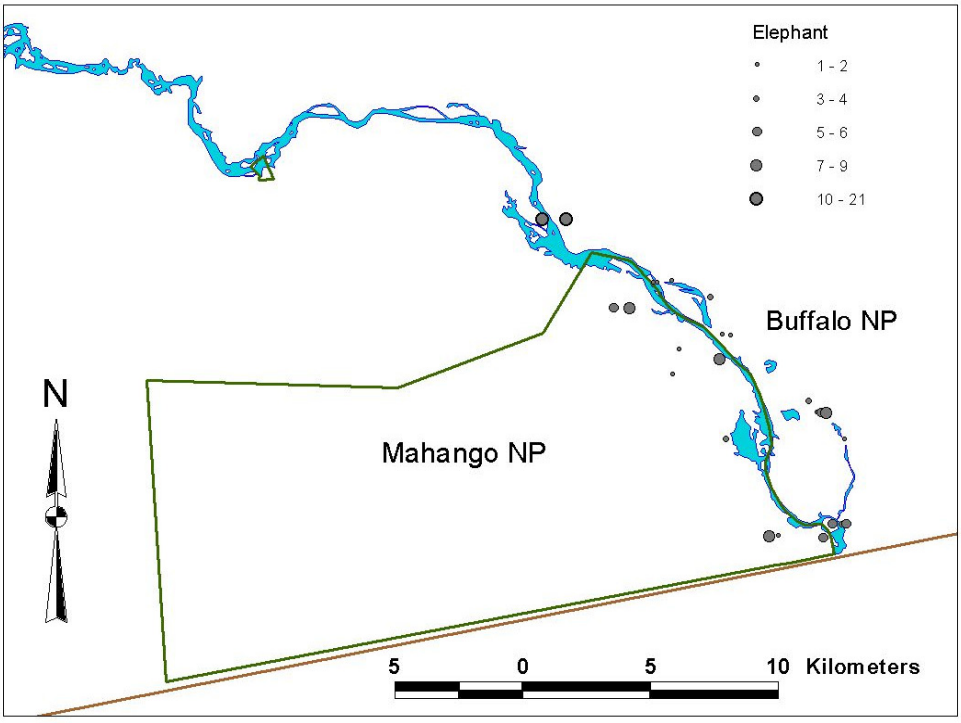


Figure 20. Distribution of elephant during aerial survey of Kavango River, Sept07.



Herd Observations and Abundance

The greatest numbers of the wildlife species observed occurred in the protected areas (Table 1). For hippo, 20 herds were observed in community conservancies compared to 194 herd observations in protected areas. The largest herd observations of lechwe were in the Kwandu conservancy (9), while Susuwe had the largest herd observations (58) for a protected area.

Elephant and buffalo herds largely occurred along the major perennial rivers and adjacent floodplains in protected areas. Within the protected areas the most elephant herds (226) were observed in Mamili NP. These herds typically occurred in the thick *Phragmites* reeds, which were surrounded by water. The total number of elephant herds observed in protected areas numbered 283, compared to 16 elephant herds observed in conservancies. We recorded three herd observations for impala in the conservancies.

A total of 17,050 wildlife species were observed during the aerial survey (Table 2). For wetland species hippo occurred in greatest numbers (1,269), further we recorded 1,924 Pelicans, which were mainly concentrated alongside 10 km of the Chobe River. Buffalo occurred in the highest numbers (5,951) followed by elephants (3,062).

The number of animals counted per square kilometer increased for many of the stratum between the Aug 04 and Sept 07 survey (Figure 20). The Kavango stratum had the highest densities of wildlife species. Similar to the Aug04 survey we observed larger numbers of wildlife species in the protected areas compared to conservancies. Except for hippo, we recorded greater densities for all species, in both protected and community conservancies (Figure 21) when compared to the Aug04 aerial survey. During our Sept07 survey, the density of woodland species doubled in both protected and community conservancies (Table 3).

Within the community conservancies, the density of wetland species increased between the Aug04 and Sept07 survey. While we observed fewer hippo in protected areas (1,056 vs 920), the number of hippo in community conservancies increased (69 vs 91). The density of lechwe between the various conservancies was variable, but reedbuck occurred in higher densities (Figure 22). While Kasika and Impalila recorded the highest densities of mokoros and cattle they also had the highest densities of crocodile, elephant and buffalo.

We extended our flight transects over the Chobe / Linyanti stratum to include Lake Liambezi. Although the lake had water, we only observed two reedbuck and four pelicans near the lake. The lake is surrounded by human settlement and has the potential to support a greater diversity of birdlife when it receives water.

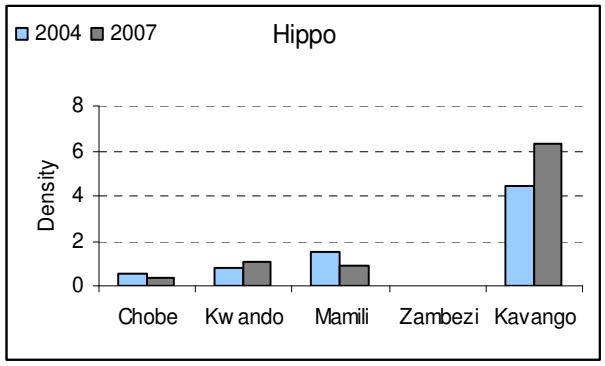
Table 1. Herd observations (Obs) and mean (Av.) herd sizes in protected areas and conservancies on the aerial survey of Caprivi river systems, Sept07.

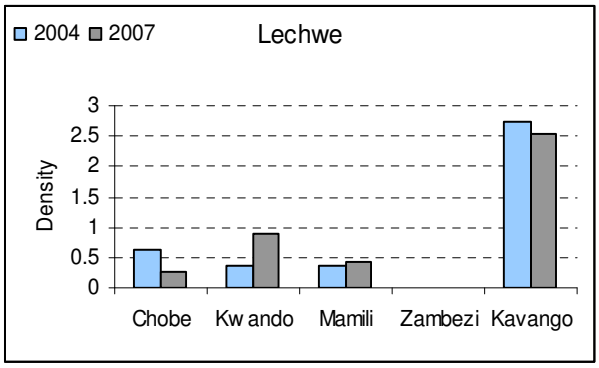
	Water/floodplain species								Other common species							
	Hippo		Lechwe		Reedbuck		Crocodile		Buffalo		Elephant		Impala		Zebra	
Protected Area	Av.	Obs	Av.	Obs	Av.	Obs	Av.	Obs	Av.	Obs	Av.	Obs	Av.	Obs	Av.	Obs
Mahango/Buffalo	7	54	6	24	3	13	2	20	32	27	5	25	8	19	13	3
Susuwe	6	11	4	58	2	41	1	1	89	10	22	4	12	9		
Mudumu	4	26	4	5	4	1	1	5	59	2	10	21	15	2	6	10
Mamili	4	93	5	29	2	17	1	38	127	15	9	226	13	11		
Chobe NP	6	10	34	4			2	29	252	8	14	7	58	13	51	7
Sub Total		194		120		72		93		62		283		54		7
Conservancies																
Kwandu	5	3	3	9	1	8	1	4					8	1		
Mayuni			3	4	2	2	1	1								
Mashi	1	3	4	4	2	3	1				2					
Balyerwa	6	4					1	2			5	5				
Salambala	6	1					1	1					27	2	48	11
Kasika	3	4	4	1			1	8	22	4	31	10				
Impalila	7	5					1	11	40	1	14	1				
Sub Total		20		18		13		27		5		16		3		11

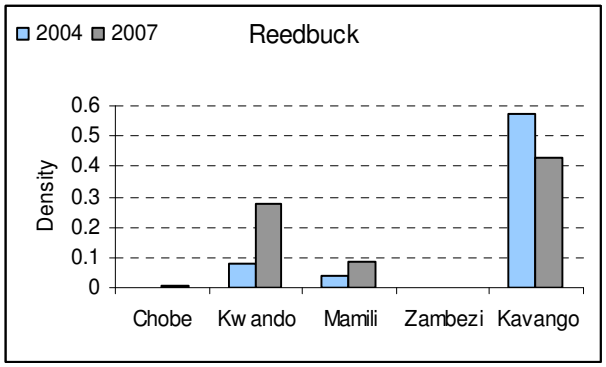
Table 2. Total number of wildlife species counted in five strata on two aerial surveys (2004 and 2007) of the Caprivi river systems, Namibia.

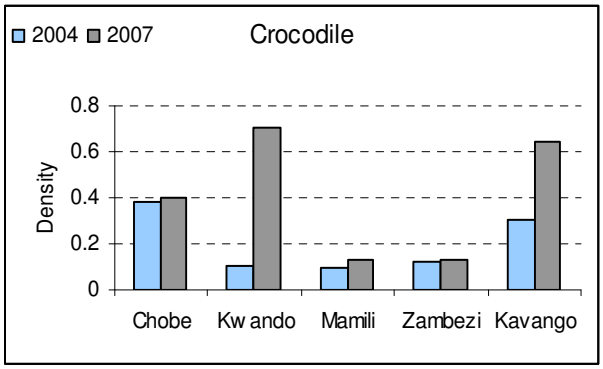
Species	Survey Stratum and Species Counted										Total	
	Linyanti/Chobe		Kwando		Mamili NP		Zambezi		Kavango			
Year	2004	2007	2004	2007	2004	2007	2004	2007	2004	2007	2004	2007
Baboon		15	20	40	118	50			20		158	105
Buffalo	918	2043	304	1040	993	1902	232	105	815	861	3262	5951
Bushbuck				1	2				4	2	6	3
Crocodile	58	60	40	40	37	48	55	59	17	36	207	243
Elephant	73	259	267	453	473	1935	4	293	43	122	860	3062
Hippopotamus	255	173	308	389	560	344	17	12	247	351	1387	1269
Giraffe	8	1			13						21	1
Impala	485	801	64	262	150	142			43	156	742	1361
Kudu	4	14	6	12	31	27			57	81	98	134
Lechwe	314	134	132	331	137	156	1	4	154	142	738	767
Lion	4	8				2					4	10
Pelican	498	1919				5					498	1924
Reedbuck		3	29	102	15	33			32	24	76	162
Sable				22					45	80	45	102
Sitatunga			2	5		2					2	7
Tsessebe			4	31					21		25	31
Warthog	18	8	17	30	182	123			9	15	226	176
Wattled Crane			6			13			2	11	8	24
Waterbuck	53	27	7	3							60	30
Wildebeest		14		21					6		6	35
Zebra	1047	1558	13	57					24	38	1084	1653
Total	3735	7037	1219	2839	2711	4782	309	473	1539	1919	9513	17050

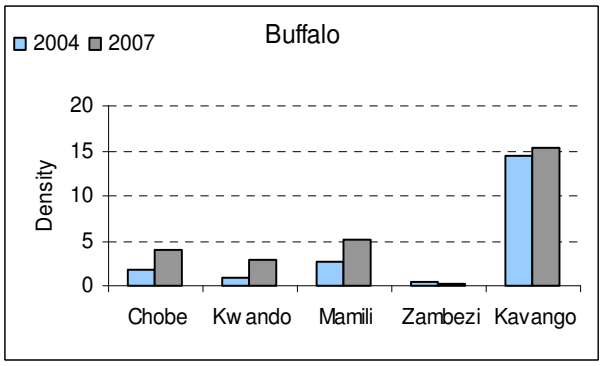
Figure 21. Density (km^2) of wildlife species by strata and differences between the Aug04 (2004) and Sept07 (2007) aerial surveys.

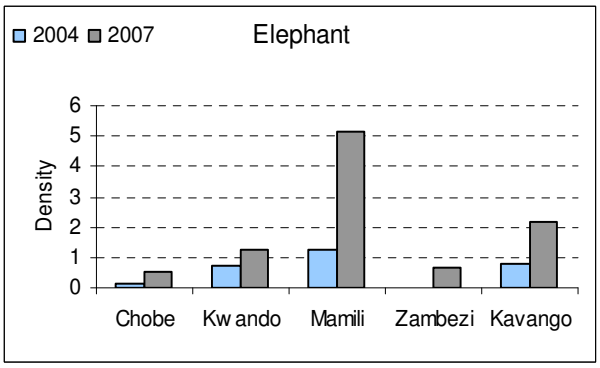


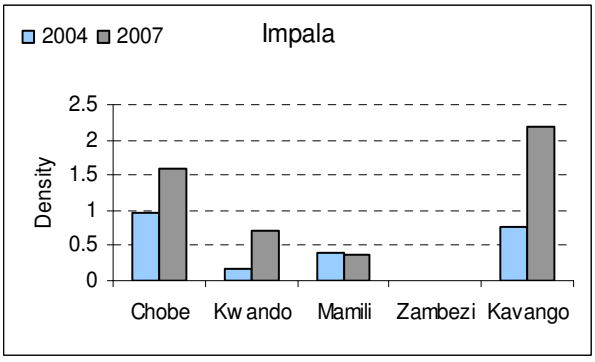












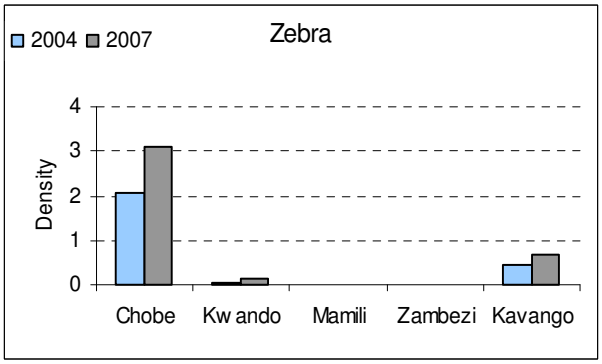
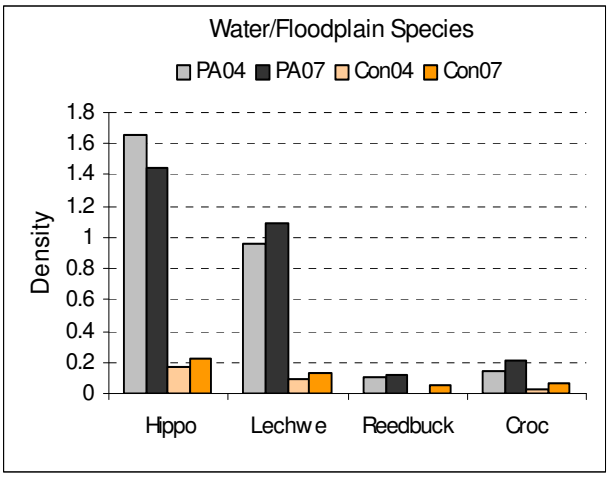


Figure 22. Density (km^2) of water/floodplain and woodland species between protected areas (pa) and conservancies (con) on two aerial surveys (Aug04 and Sept07).



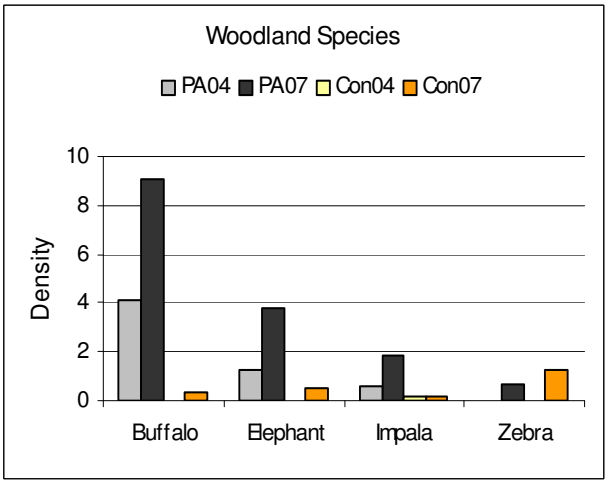
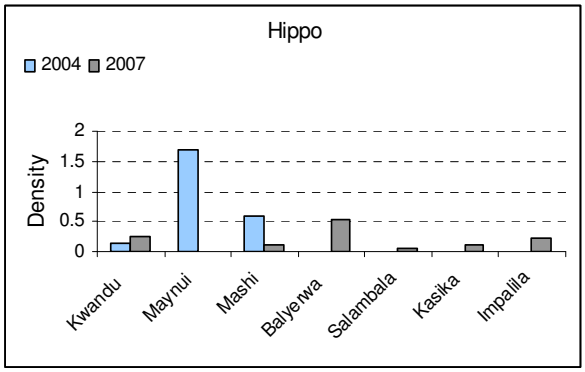


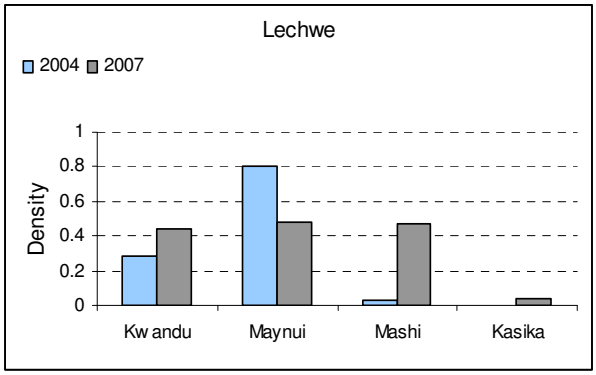
Table 3. Wildlife species counted and densities (km^2) in Protected Areas and Conservancies.

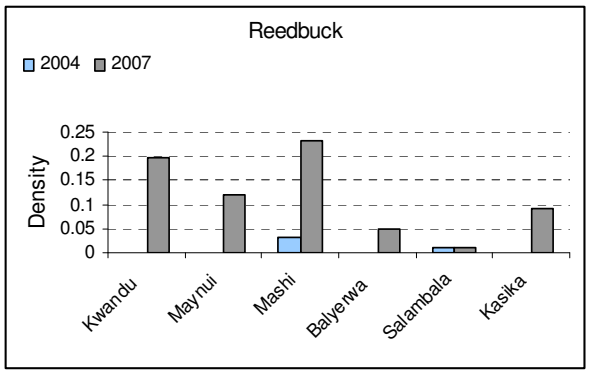
Protected Area	Area (km^2)	Water/Floodplain Species															
		Hippo				Lechwe				ReedBuck				Crocodile			
		Numbers		Density		Numbers		Density		Numbers		Density		Numbers		Density	
		2004	2007	2004	2007	2004	2007	2004	2007	2004	2007	2004	2007	2004	2007	2004	2007
Mahango/Buffalo	48	187	351	3.90	7.31	155	142	3.23	2.96	29	24	0.60	0.50	23	35	0.48	0.73
Susuwe	94	91	67	0.97	0.71	62	245	0.66	2.61	20	63	0.21	0.67	6	1	0.06	0.01
Mudumu	65	34	97	0.52	1.49	3	22	0.05	0.34	2	4	0.03	0.06	2	5	0.03	0.08
Mamili	377	560	344	1.49	0.91	137	156	0.36	0.41	15	33	0.04	0.09	37	48	0.1	0.13
Chobe NP	54	184	61	3.41	1.13	258	134	4.78	2.48					27	48	0.5	0.89
Sub Total	638	1056	920	1.66	1.44	615	699	0.96	1.10	66	124	0.10	0.19	95	137	0.15	0.21
Conservancies																	
Kwandu	56	8	14	0.14	0.25	16	25	0.29	0.45		11		0.20	8	5	0.14	0.09
Mayuni	25	42		1.68		20	12	0.80	0.48		3		0.12		1		0.04
Mashi	30	18	3	0.60	0.10	1	14	0.03	0.47	1	7	0.03	0.23	4		0.13	
Balyerwa	41		22		0.54										2		0.05
Salambala	86	1	6	0.01	0.07									1	1	0.01	0.01
Kasika	105		13		0.12		4		0.04						9		0.09
Impalila	70		33		0.47										12		0.17
Sub Total	413	69	91	0.17	0.22	37	55	0.09	0.13	1	21		0.05	13	30	0.03	0.07

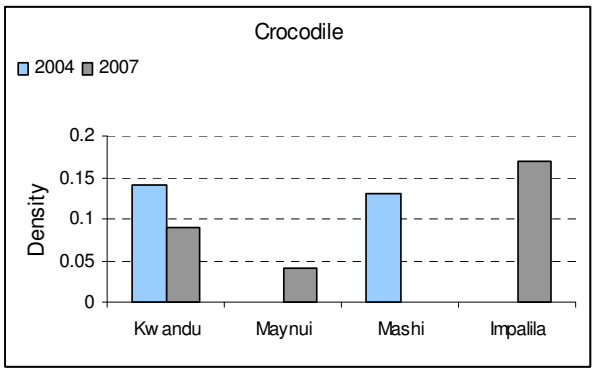
Protected Area	Area (km^2)	Woodland Species															
		Buffalo				Elephant				Impala				Zebra			
		Numbers		Density		Numbers		Density		Numbers		Density		Numbers		Density	
		2004	2007	2004	2007	2004	2007	2004	2007	2004	2007	2004	2007	2004	2007	2004	2007
Mahango/Buffalo	48	214	861	4.46	17.94	25	122	0.52	2.54	46	156	0.96	3.25		38		0.79
Susuwe	94	735	886	7.82	9.43	18	89	0.19	0.95	5	105	0.05	1.12				
Mudumu	65	15	117	0.23	1.80	240	180	3.69	2.77	38	29	0.58	0.45		57		0.88
Mamili	377	993	1902	2.63	5.05	473	1935	1.25	5.13	150	142	0.40	0.38				
Chobe NP	54	660	2019	12.22	37.39	44	99	0.81	1.83	112	748	2.07	13.85		355		6.57
Sub Total	638	2617	5785	4.10	9.07	800	2425	1.25	3.80	351	1180	0.55	1.85		450		0.71
Conservancies																	
Kwandu	56																
Mayuni	25									3		0.12					
Mashi	30						2		0.07								
Balyerwa	41						26		0.63								
Salambala	86								0.00	77	53	0.9	0.616		527		6.13
Kasika	105		89		0.85		171		1.63								
Impalila	70		40		0.57		14		0.20								
Sub Total	413		129		0.31		213		0.52	80	53	0.19	0.128		527		1.3

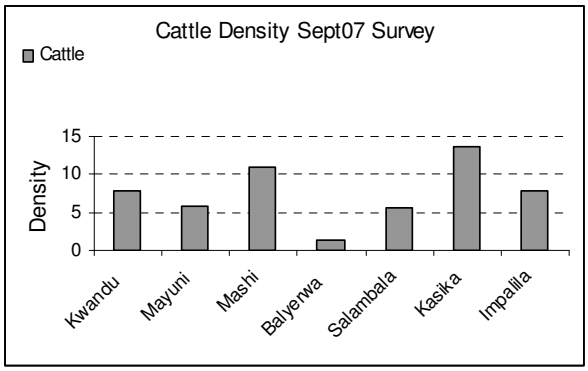
Figure 23. Density (km^2) of wildlife species, cattle and mokoros in community conservancies and differences between the Aug04 (2004) and Sept07 (2007) aerial surveys.

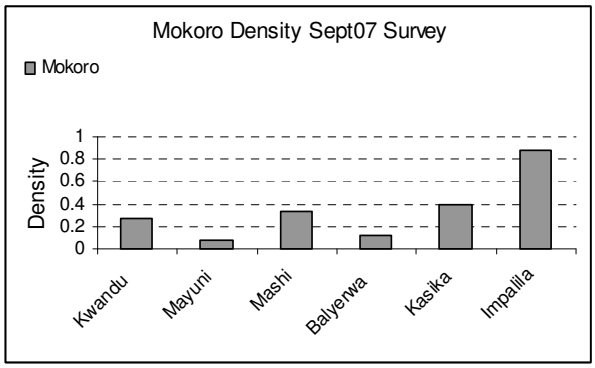


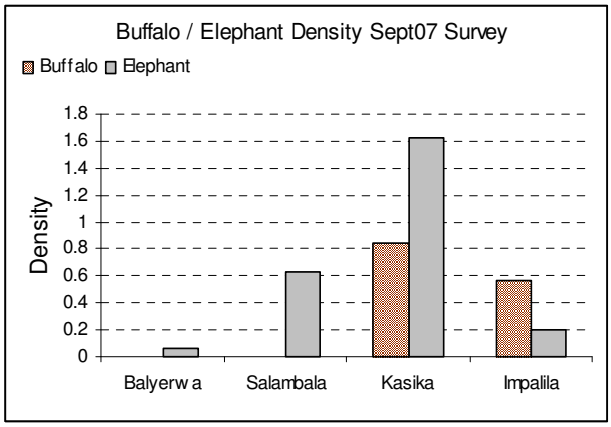












In addition to wildlife species we recorded cattle and mokoro numbers. For the Zambezi Stratum, stretching from the Kazungula ferry crossing to Katima Mulilo (~160 km) we observed 915 mokoros (Table 4).

Table 4. The numbers of cattle and mokoro in each stratum.

Obs	Strata			Total
	Kwando	Chobe	Zambezi	
Cattle	973	2418	6733	10124
Mokoro	38	169	915	1122

Discussion

Wildlife Distribution

Most wildlife species occurred within protected areas. Elephants and buffalo tend to avoid the conservancies adjacent to the Kwando River, however along the Chobe River in the Kasika and Impalila conservancies they occur in higher densities despite numerous human settlements along the rivers. It would appear that vulnerable floodplain species such as reedbuck, sitatunga and lechwe are extending their ranges into community conservancies. Our observers sighted crocodile, in the seasonal floodplains away from the major river channels. This distribution underscores the importance of these habitats to sustaining healthy crocodile populations. The Kavango and Chobe strata had the highest wildlife densities.

Herd Observations and Abundance

There were fewer herd observations for the Aug04 survey compared to our Sept07 survey. The greatest variation in herds observed between the two surveys occurred for elephants. On the Aug04 survey, 106 elephant herds were observed, compared to 299 in Sept07. We also observed double the number of reedbuck herds; 42 in Aug04 compared to 85 in Sept07. The Sept07 survey recorded fewer observations of crocodile groups (120) compared to 154 in Aug04. However, we counted more crocodiles during the Sept07 survey (243) than the Aug04 survey (207), meaning we saw more crocodiles in any one group. Hippo pods were more numerous on the Aug04 survey (289) than on the Sept07 survey (214).

Variations in Wildlife Densities

Wildlife observations increased by nearly 79% during the Sept07 survey (17,050) compared to the Aug04 survey (9,513). This suggests that wildlife numbers are increasing in the Caprivi region of Namibia. For all species, except hippo, warthog and waterbuck we observed considerably more animals than the Aug04 survey. Community conservancy programmes have a strong commitment towards conservation, which in turn contributes to increased tolerance of wildlife species in these communities (Brown 2007).

Variations in wildlife densities may be attributed to movements from Botswana in to the Caprivi and the implementation of community conservancy projects, which encourage wildlife conservation. Further, the variations in wildlife abundance may be attributed to the rigorous methodology adopted by the Sept07 survey team (Appendix 1). The reasons for the decline in wildlife numbers in the Mayuni conservancy are unknown but may be attributed to the timing of our aerial survey, and the extensive bush fires in the area.

Conclusion

Wildlife numbers along the river systems of the Caprivi are increasing. Our Sept07 survey observed 79% more wildlife observations than a survey conducted in Aug04. The increase in wildlife numbers both within the protected and conservancy areas may be attributed to both the seasonal dispersal and movement of wildlife within the Caprivi and between Botswana and the Caprivi, as well as the effects of local conservation initiatives on wildlife breeding, successful reintroductions and survival. This trend suggests that larger numbers of wildlife within community conservancies can be attributed to CBNRM and conservancy initatives, which are facilitating growing wildlife numbers through socio-economic incentives provided under the conservancy policy and programme.

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Appendix

Appendix 1. Comparisons between observer and photo corrected observations and timing of aerial surveys.

We suspect the variations in wildlife numbers between the Aug04 and Sept07 aerial surveys may be attributed to the timing of surveys, observer experience and the rigorous photo verification method used on the Sept07 survey. It has further been suggested that differences in wildlife numbers are also due to conservation measures being implemented by conservancies, park-conservancy collaboration and co-management initiatives (Brown, 2007). An accurate assessment of wetland and woodland species numbers and distribution during aerial surveys is essential for determining conservation priorities, for identifying and monitoring important sites, and for assessing the results of targeted conservation action. We should work to standardize the timing and methodology of wetland surveys in the Caprivi. To better understand the implications of survey timing and observer estimates of large herds, we undertook a small comparative survey exercise along the Chobe River.

We undertook four aerial surveys (two morning and two afternoon) over the same area of the Chobe River at different times of the day. Transects started at the Kazungula ferry crossing and ended at the Ngoma Border Bridge. We flew the exact route up and down the middle of the river by following the previous flights track log.

The objectives of this exercise were to evaluate the reliability of our observers when counting large animal herds greater than 50. Observers commonly underestimate wildlife numbers as such aerial surveys underestimate population densities. Large herds of buffalo, elephant, hippo and flocks of water birds are common along perennial rivers such as the Chobe. In addition, these repeated surveys would help determine the temporal and spatial variation in wildlife numbers along the rivers. The proportion of wildlife observations that are observed during a survey depends largely on the time of day the survey was conducted. This information would help identify optimal times at which to fly surveys to better estimate wildlife numbers.

Our results suggest that during our aerial survey of the Caprivi rivers, wetlands and floodplains, our aerial observers were accurate in estimating elephant numbers and other wildlife observations that were under 50 animals. However, despite their extensive aerial survey experience (950h) when herds exceeded 50 animals the observers underestimated animals, in some cases by as much as 50% (Table 1).

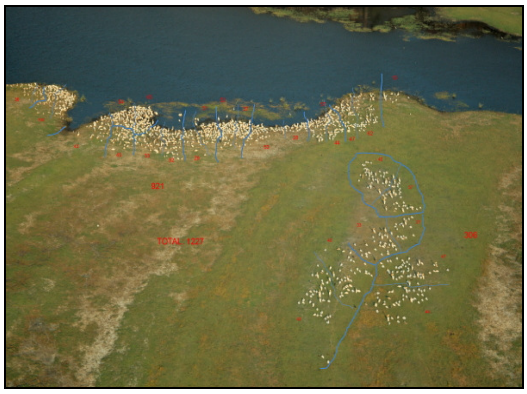
Table 1. Differences in observer estimates of wildlife species and photo verified observations

Species	Observer	Photo	Missed	% Difference
Buffalo	3046	5951	2905	48.8%
Crocodile	242	242		
Elephant	2811	3077	266	8.6%
Hippo	1146	1254	108	8.6%
Impala	1118	1361	243	17.9%
Kudu	131	134	3	2.2%
Lechwe	708	752	44	5.9%
Pelicans	1130	1924	794	41.3%
Sable	83	102	19	18.6%
Wildebeest	35	35		
Zebra	1357	1653	296	17.9%

Despite this survey being a total count, and we suspect we are observing all animals, our simple analysis suggests that we may be underestimating many species when we do not have the ability to cross reference observers call-outs with high quality digital images. Photo verification should be used on future aerial surveys, to improve the precision of the density index and obtain a visibility correction factor.

Observer estimate of Pelicans (300)

Photo corrected estimate of Pelicans (1,227)



To maximize survey results, it is important to fly when animals are most likely to occur along the river systems (Table 2). We recommend that surveys be conducted during the periods of species-specific peak occurrence along the rivers and when visibility is highest. When particular animals will be seen along the rivers or out of the water is dependent upon their drinking and feeding ecology or thermo regulation. Early morning aerial surveys are more appropriate for estimating woodland species such as buffalo and elephants. Many of these animals were observed grazing on the open floodplains, but by the afternoon their numbers had declined by 80%, when these animals were in the woodlands. However, early morning surveys (7:00 – 8:00) are clearly not a reliable indicator for estimating crocodiles. We saw half the number of crocodiles compared with surveys later in the day when crocodile typically come out of the water and sun themselves on the banks. Based upon the times we flew our four surveys it would appear that the optimal time for counting wildlife would be between 8:00 and 11:00. We suggest that river surveys in the Caprivi be flow between these times.

Table 2. Number of species and herd observations on four aerials surveys over the Chobe River.

Species	Survey ID	Time of Survey	Total # Counted[1]	Herds Observed
Buffalo	ChobeAMA	7:19-7:46	1147	10
	ChobeAMB	7:51-8:22	1016	11
	ChobePMA	14:29-14:53	385	9
	ChobePMB	14:55-15:23	540	9
Crocodile	ChobeAMA	7:19-7:46	25	19
	ChobeAMB	7:51-8:22	59	39
	ChobePMA	14:29-14:53	51	27
	ChobePMB	14:55-15:23	53	29
Elephant	ChobeAMA	7:19-7:46	116	6
	ChobeAMB	7:51-8:22	188	9
	ChobePMA	14:29-14:53	665	28
	ChobePMB	14:55-15:23	569	25
Hippo	ChobeAMA	7:19-7:46	75	15
	ChobeAMB	7:51-8:22	91	17
	ChobePMA	14:29-14:53	117	13
	ChobePMB	14:55-15:23	90	11
Kudu	ChobeAMA	7:19-7:46	36	3
	ChobeAMB	7:51-8:22	6	1
	ChobePMA	14:29-14:53	8	1
	ChobePMB	14:55-15:23	7	1
Impala	ChobeAMA	7:19-7:46	389	10
	ChobeAMB	7:51-8:22	568	14
	ChobePMA	14:29-14:53	444	16
	ChobePMB	14:55-15:23	426	15
Lechwe	ChobeAMA	7:19-7:46	63	9
	ChobeAMB	7:51-8:22	110	4
	ChobePMA	14:29-14:53	57	4
	ChobePMB	14:55-15:23	92	8
Zebra	ChobeAMA	7:19-7:46	479	11
	ChobeAMB	7:51-8:22	521	12
	ChobePMA	14:29-14:53	1024	14
	ChobePMB	14:55-15:23	818	16

[1] This number has not been photo corrected