

Aerial Wildlife Census of the Caprivi River Systems *- a survey of water bodies and floodplains*

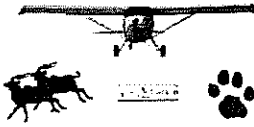
11 – 20 August 2004



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Data management: L. Conradie, S. Mayes & P Stander
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W. Cilliers, L. Conradie & P. Stander

24 August 2004

Funded by the Namibia Nature Foundation



Aerial Survey of Caprivi River Systems

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Summary

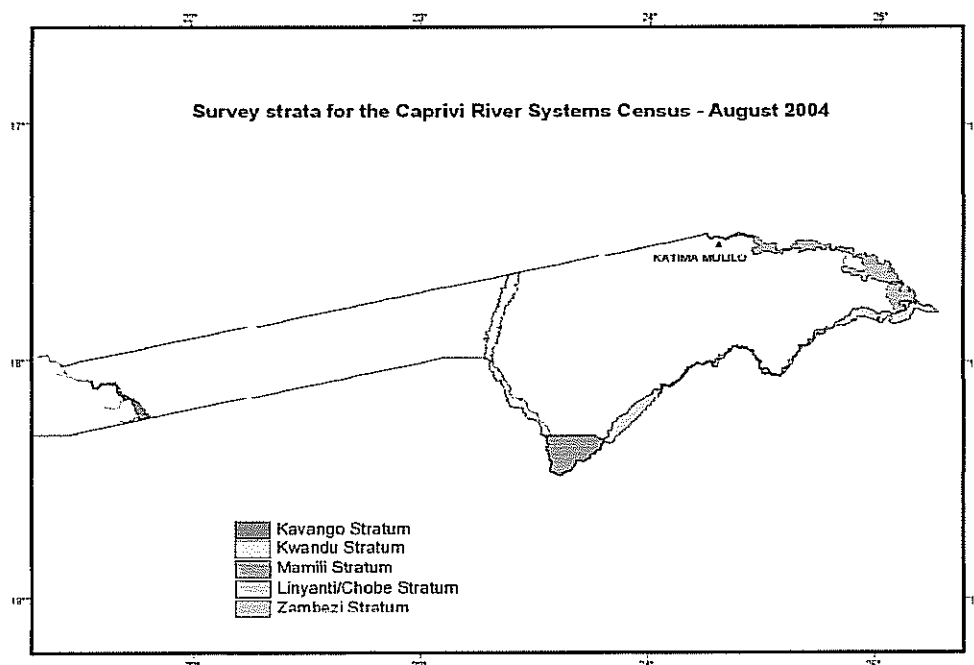
An aerial wildlife census of the Caprivi River Systems in Namibia was conducted between 11 and 20 August 2004. A total count of water bodies and floodplains of the Kavango, Kwandu, Linyanti, Chobe and Zambezi was done to assess the numbers of hippopotamuses, floodplain ungulates, crocodiles, and some large birds. Counting areas were divided into 15km² blocks and, with the use of GPS and mobile GIS technology, each block was covered intensively. Flying time amounted to 36.5 hours with an overall of 49% ferry to, and between, counting blocks. A total of 9515 animals were counted, including 1387 hippos and 538 lechwes. Wildlife numbers were highest in, or bordering, conservation areas. Distribution maps and comparisons between different ecological and management systems are presented.

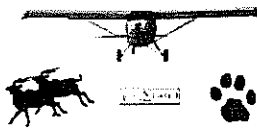
Introduction

Conservation initiatives by the Ministry of Environment and Tourism and the Namibia Nature Foundation have identified the need for a comprehensive aerial survey of some wildlife species associated with the river systems in north-eastern Namibia. The survey, funded through the Namibia Nature Foundation, will contribute important data to the Transboundary Mammal Project, the Kwandu Systems Profile, and wildlife management in both protected areas and conservancies. The survey concentrates on the water bodies and floodplains of the Caprivi and Kavango perennial river systems to count hippopotamuses, the floodplain ungulates such as reedbuck, lechwe, waterbuck and sitatunga, and crocodiles. Concurrent crocodile counts from boats took place at night, using spotlights. Other common and woodland wildlife species, and large birds (e.g. cranes) are also included in the aerial count.

Survey Area

The survey is focussed on the water bodies and floodplains of the Kavango River; Kwandu River; Mamili National Park; Linyanti/Chobe Rivers; and Zambezi River.

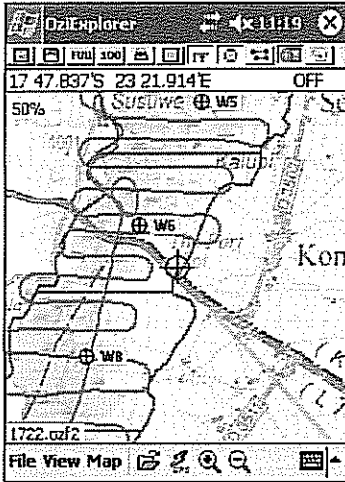




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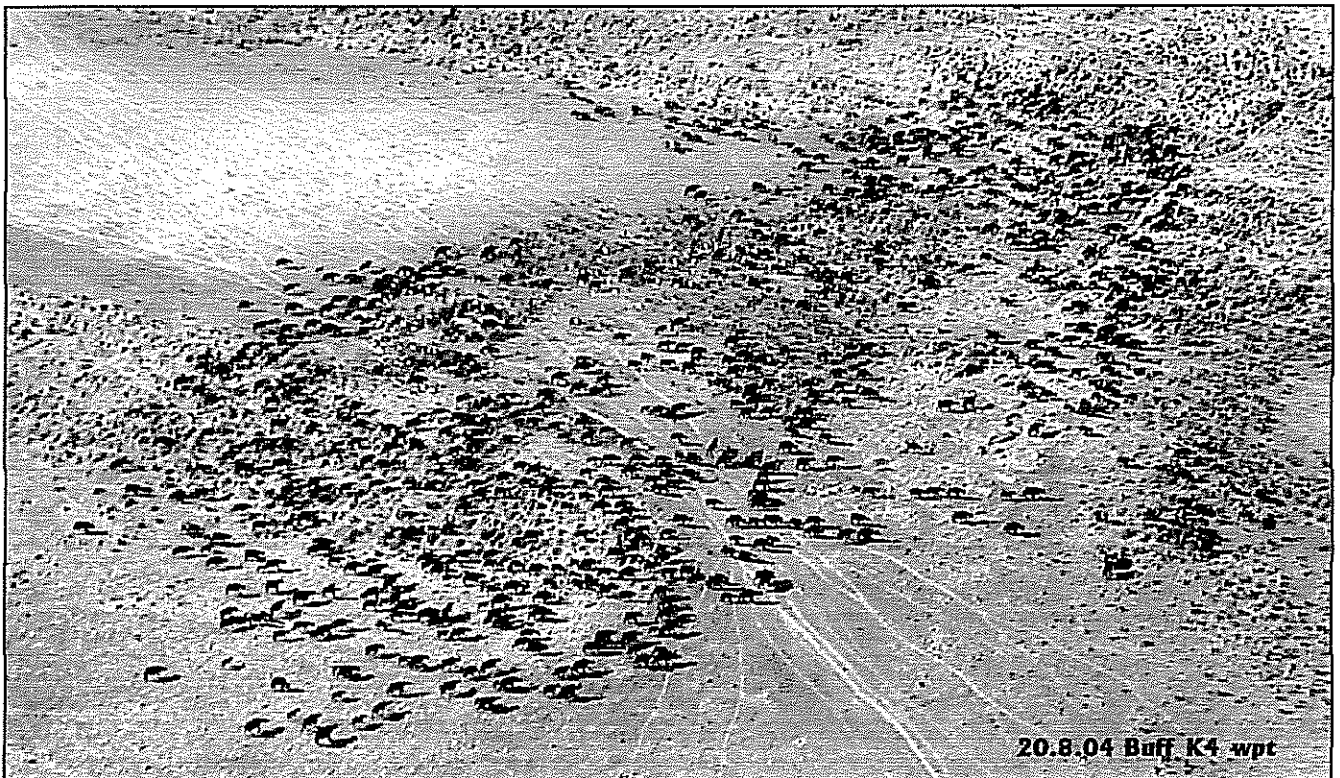
Methods and survey design

The survey was done by means of a total block-count design. Using satellite images the outer boundaries of water bodies and floodplains were delineated in five strata. Each stratum was subdivided into counting blocks of approximately 15 km² in size. Each counting block was surveyed systematically and all animals counted.



A handheld computer with digital mapping software, linked to a Bluetooth GPS, was used to navigate accurately within counting blocks. The live-capture image (left) depicts a 1:250 000 scanned topographic map as the background, with the counting block boundaries (blue lines), and the exact flight path of the aircraft (red lines). This high quality and accurate moving-map image, visible to both the pilot and the survey crew during flight, enabled good coverage of the survey blocks.

When groups of animals were large, digital photographs and video images of the groups were captured. The exact number of individuals was determined from these images.



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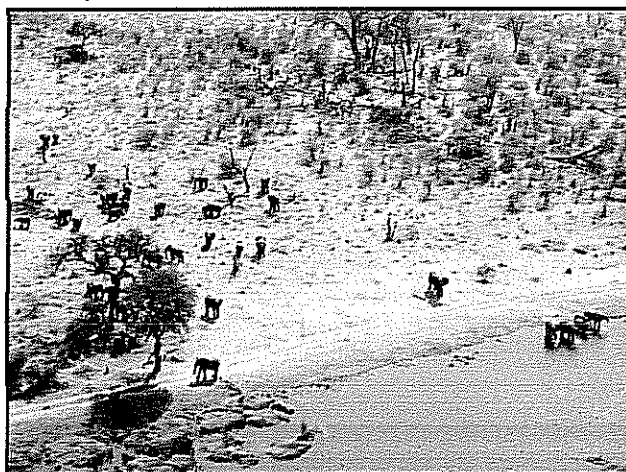
Results

Total numbers and distribution of wildlife species counted during the survey.

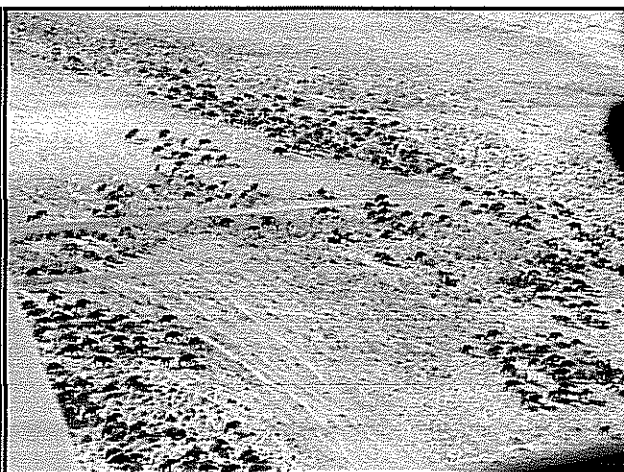
The total number of animals counted in five strata.

Species	Total	Survey stratum				
		Linyanti/Chobe	Kwando	Mamili NP	Zambezi	Kavango
Buffalo	3262	918	304	993	232	815
Hippopotamus	1387	255	308	560	17	247
Zebra	1084	1047	13			24
Elephant	860	73	267	473	4	43
Lechwe	738	314	132	137	1	154
Pelicans	498	498				
Impala	742	485	64	150		43
Warthogs	226	18	17	182		9
Crocodile	207	58	40	37	55	17
Baboon	158		20	118		20
Waterbuck	60	53	7			
Reedbuck	76		29	15		32
Kudu	98	4	6	31		57
Giraffe	21	8		13		
Wattled Crane	8		6			2
Lions	4	4				
Bushbuck	6			2		4
Duiker			1			
Steenbok				1		
Tsessebe			4			21
Sitatunga	2		2			
Wildebeest	6					6
Sable	45					45
Total	9515	3735	1220	2712	309	1539

Elephants on the Kwando River



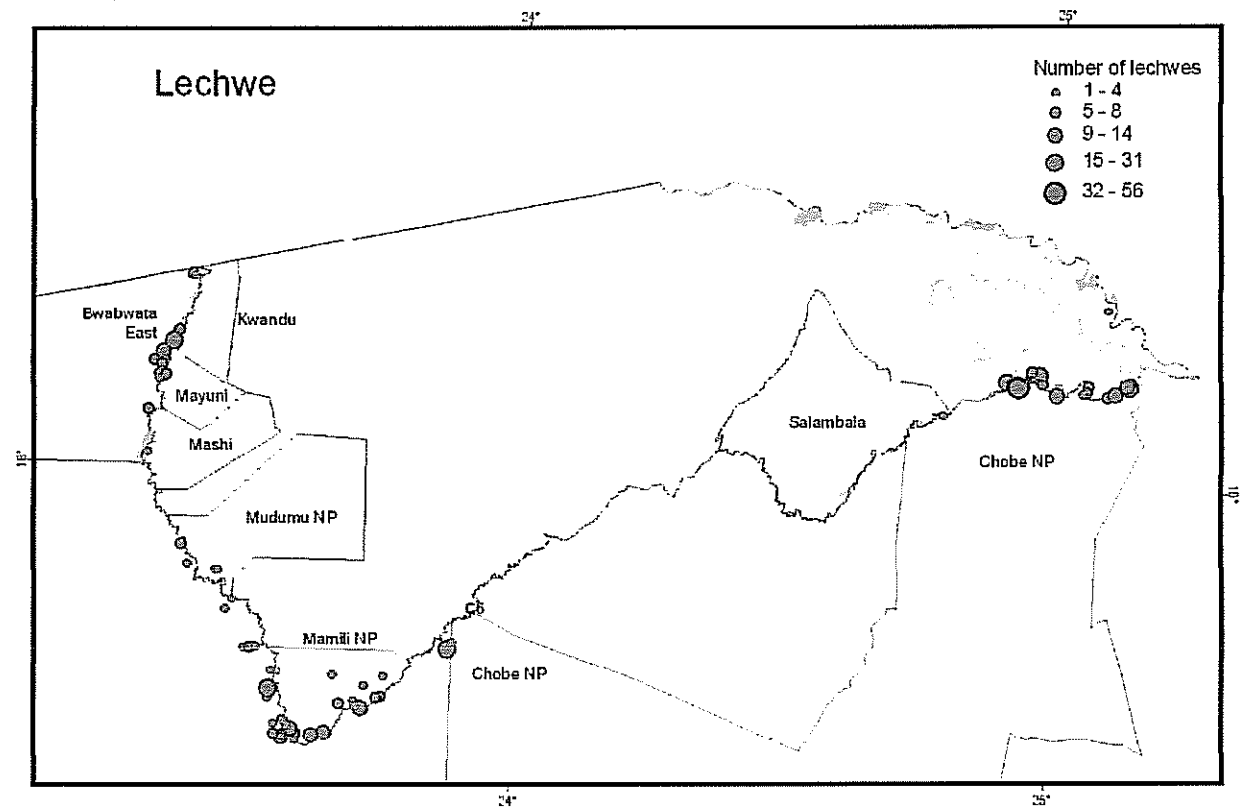
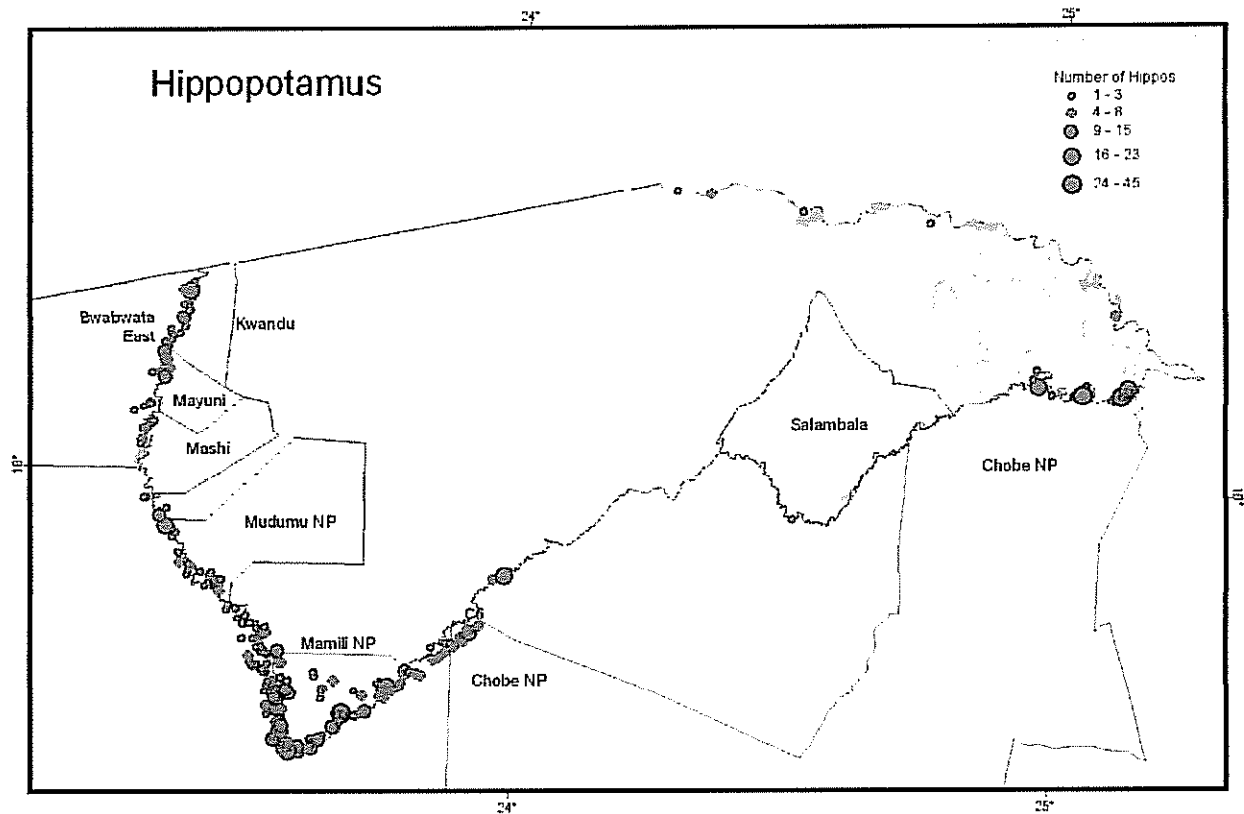
Buffaloes in Mamili National Park





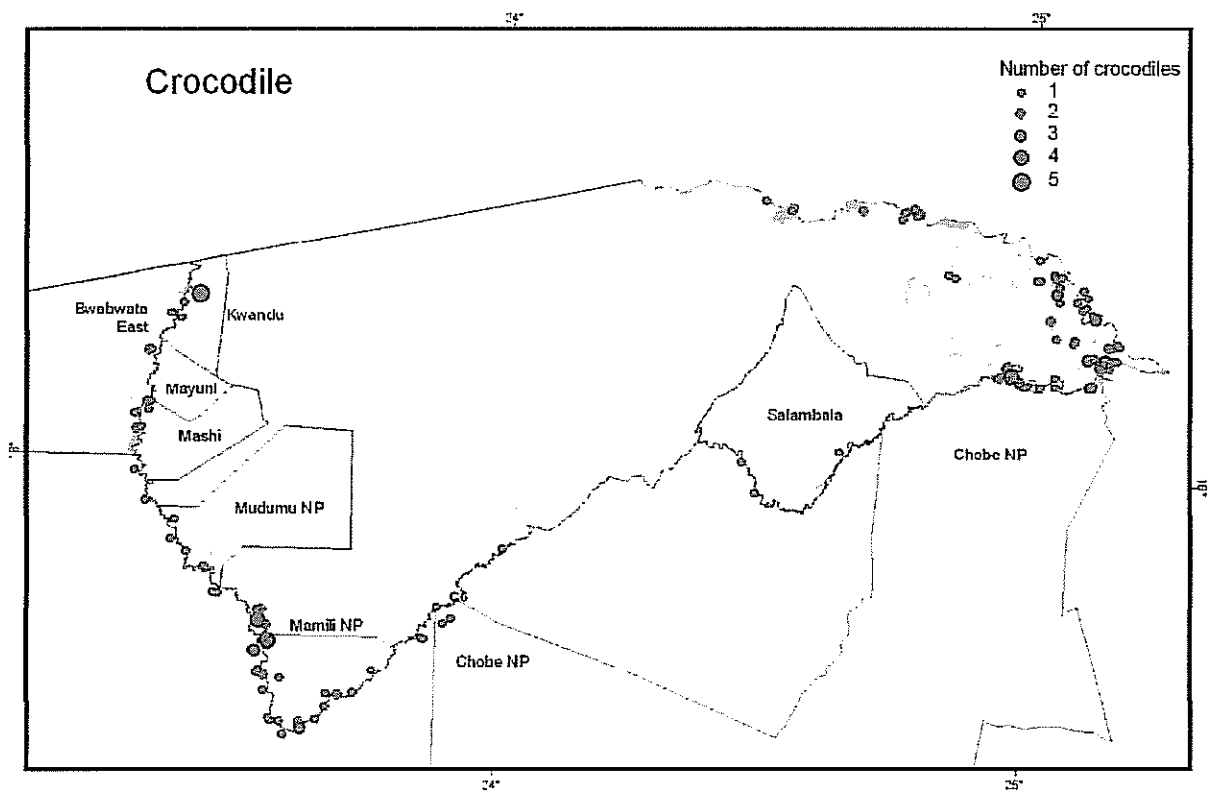
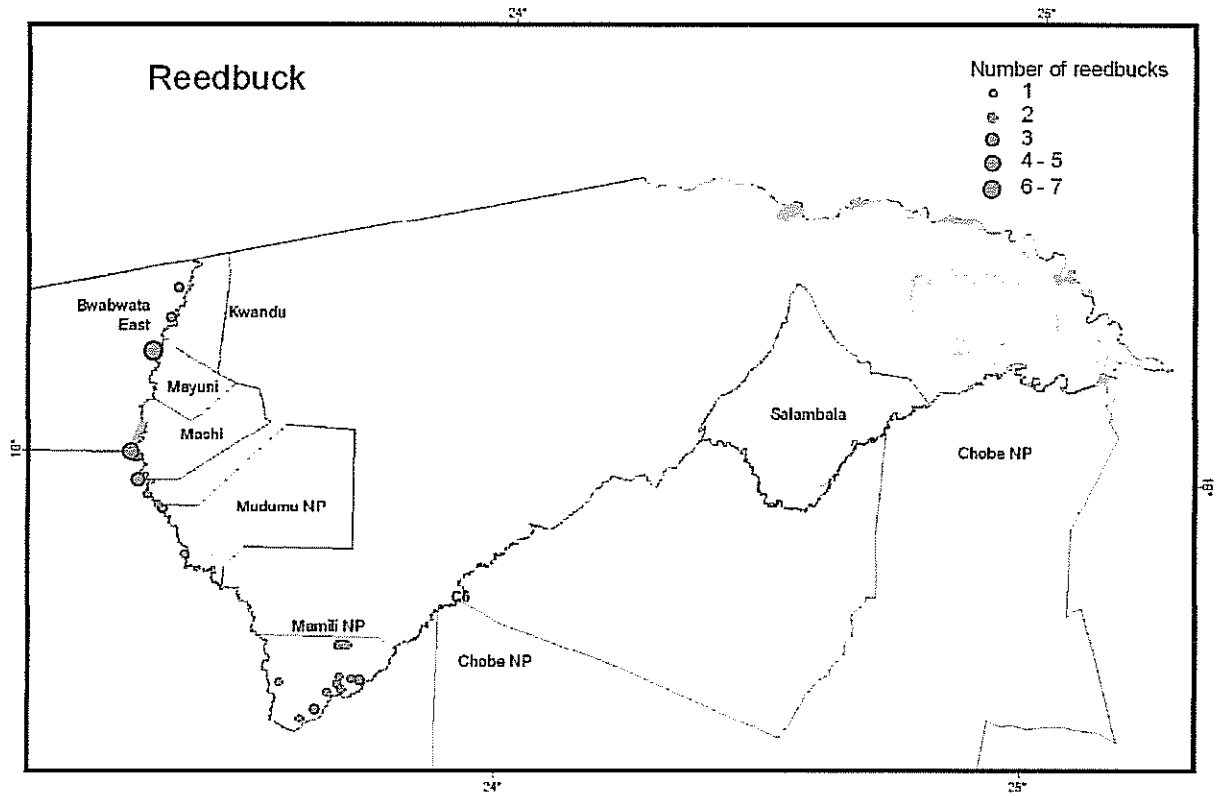
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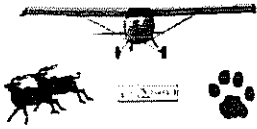
Distribution of water and flood plain species in East Caprivi.





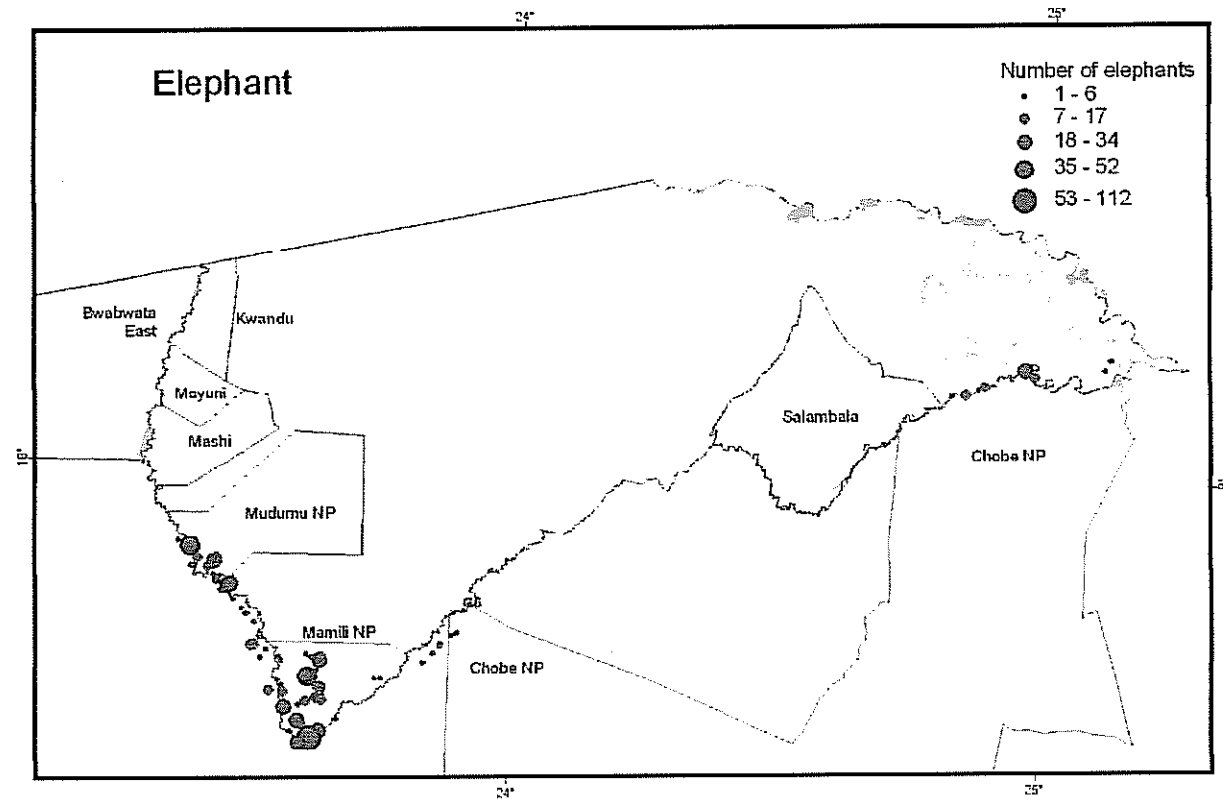
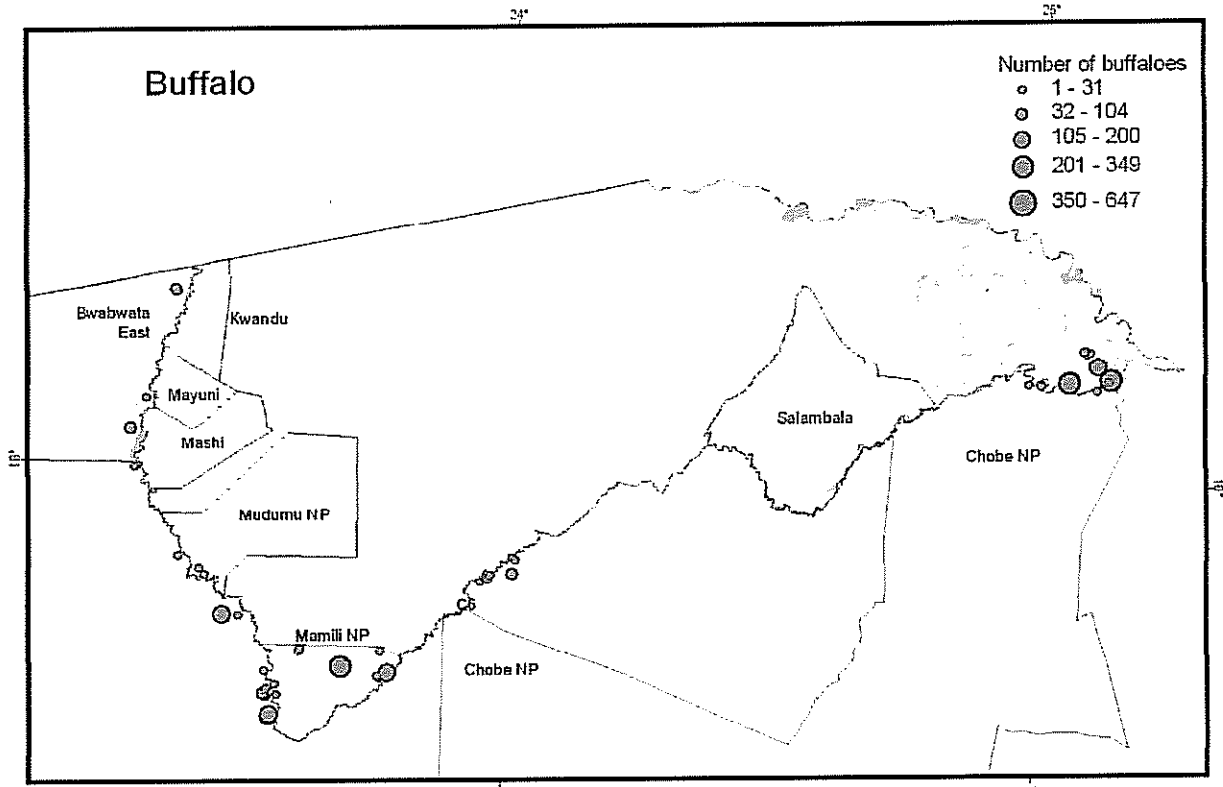
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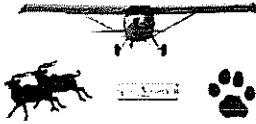




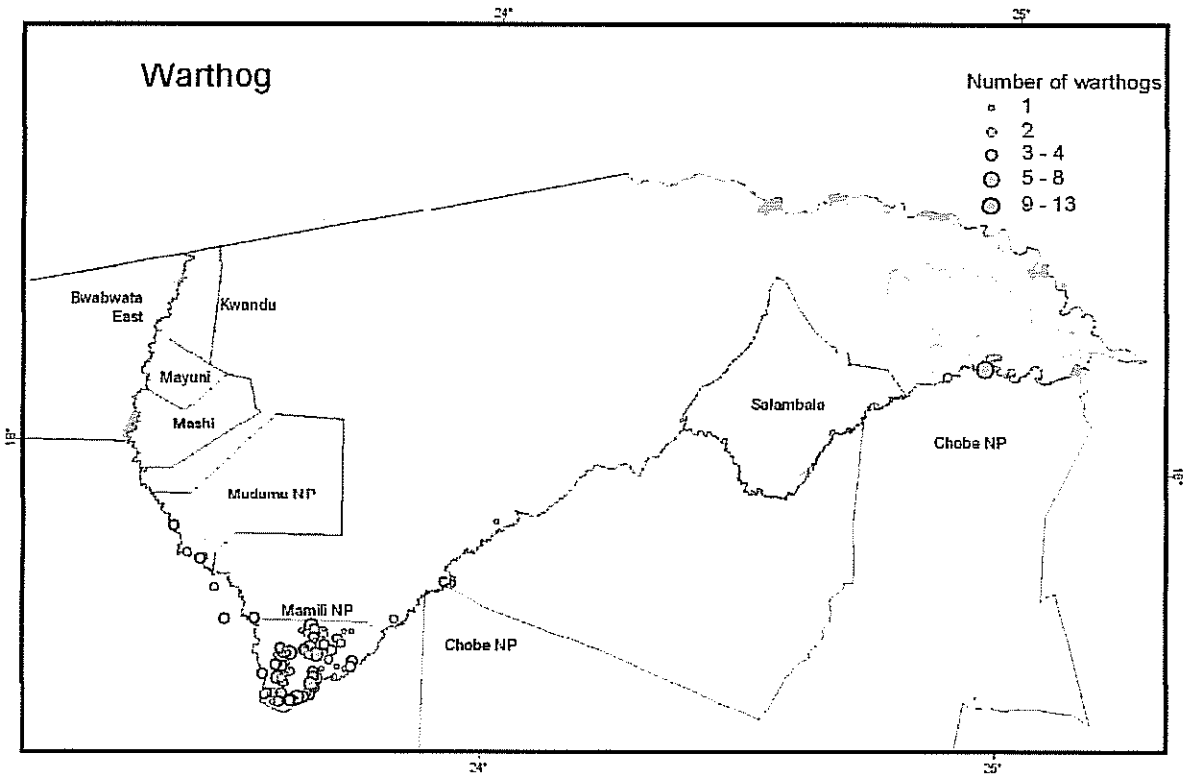
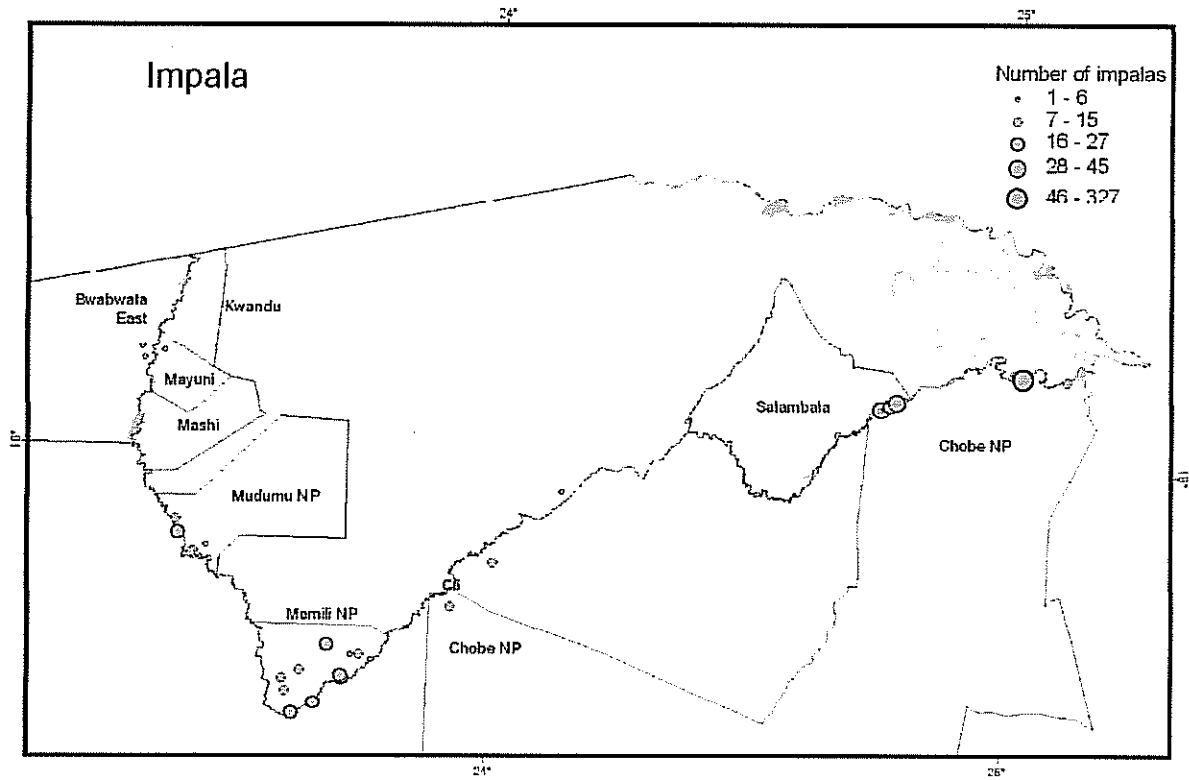
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Distribution of woodland and other wildlife species in East Caprivi.



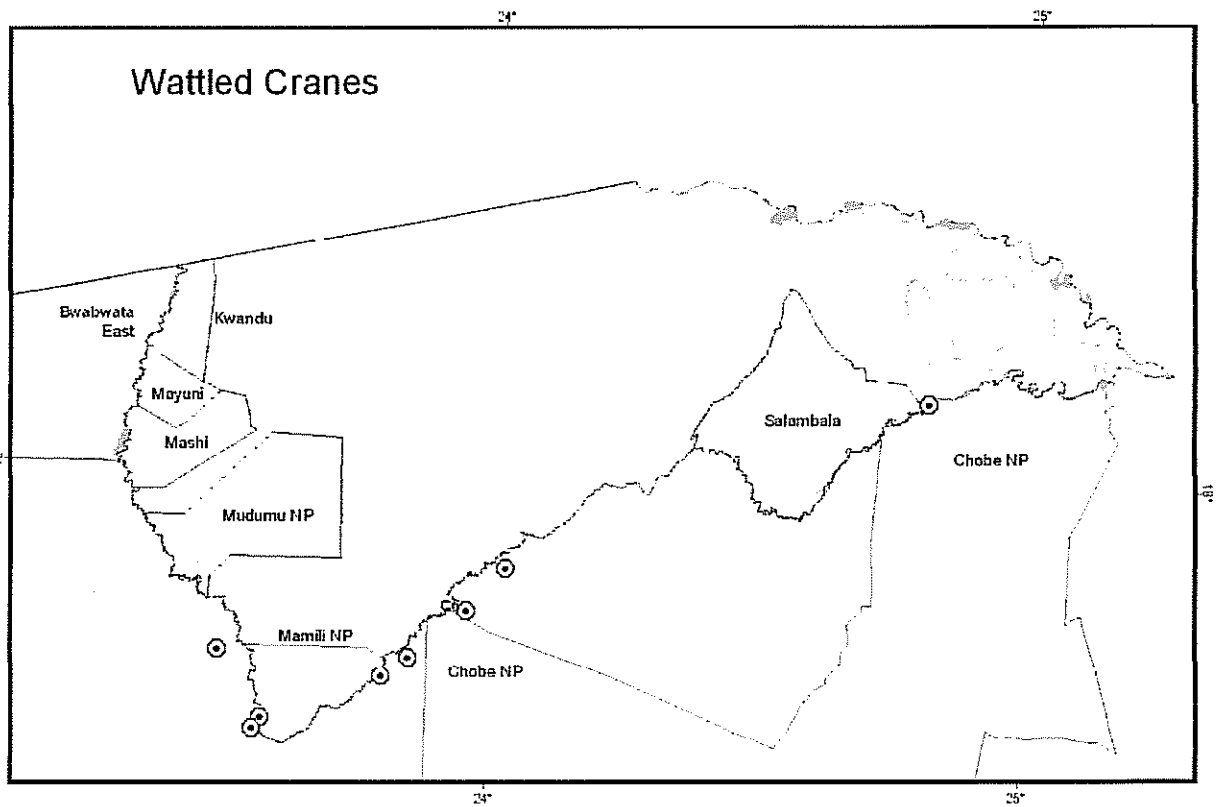
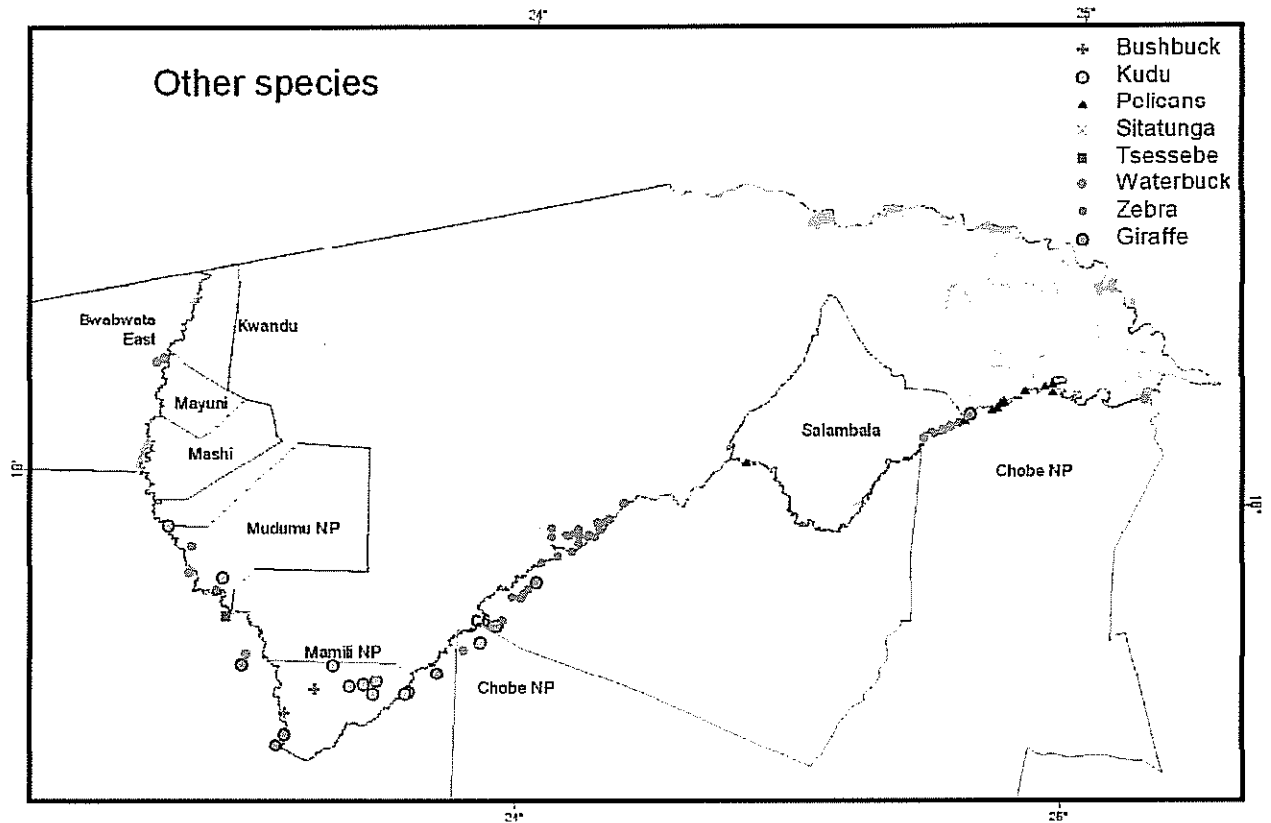


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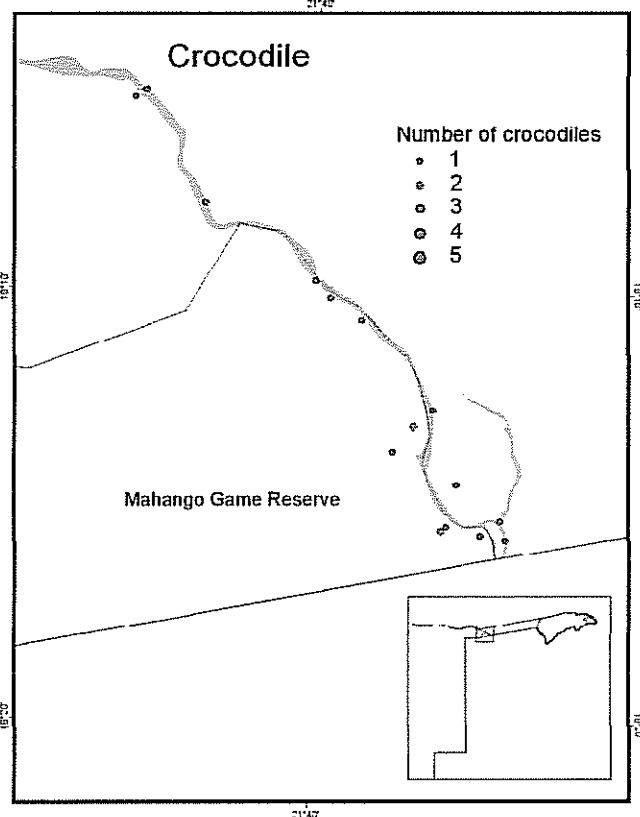
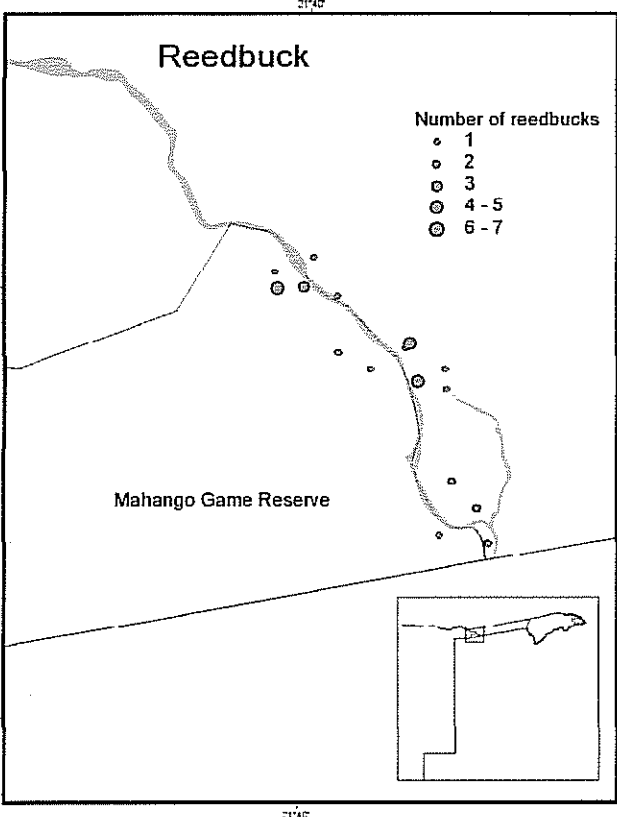
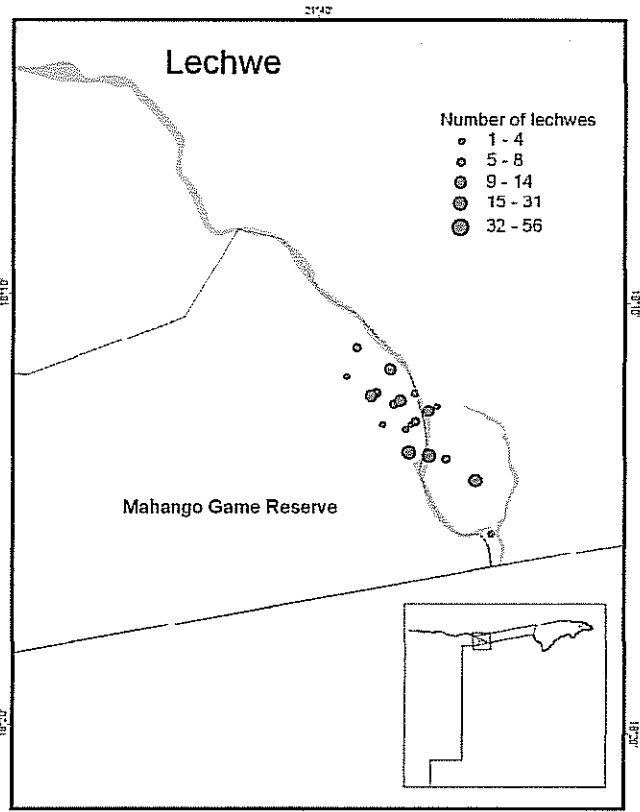
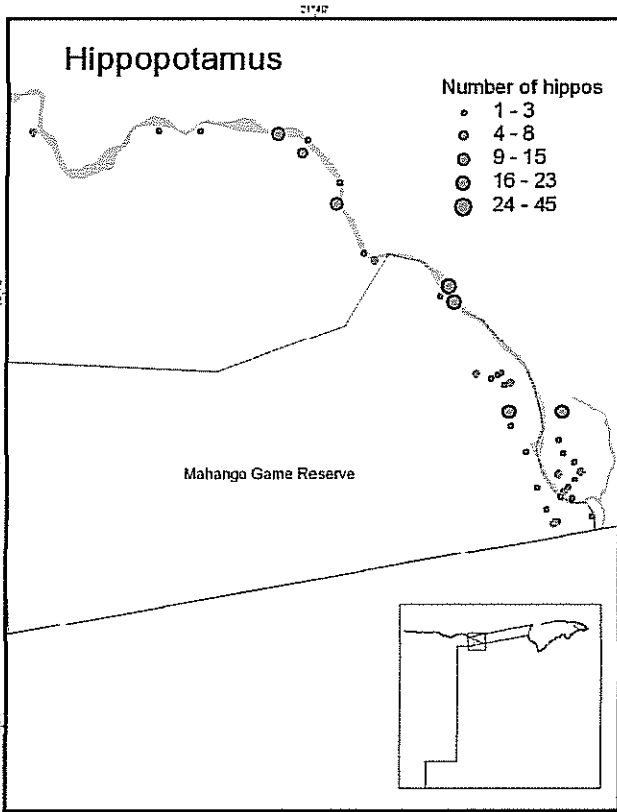


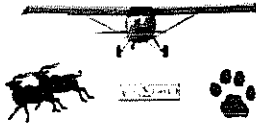


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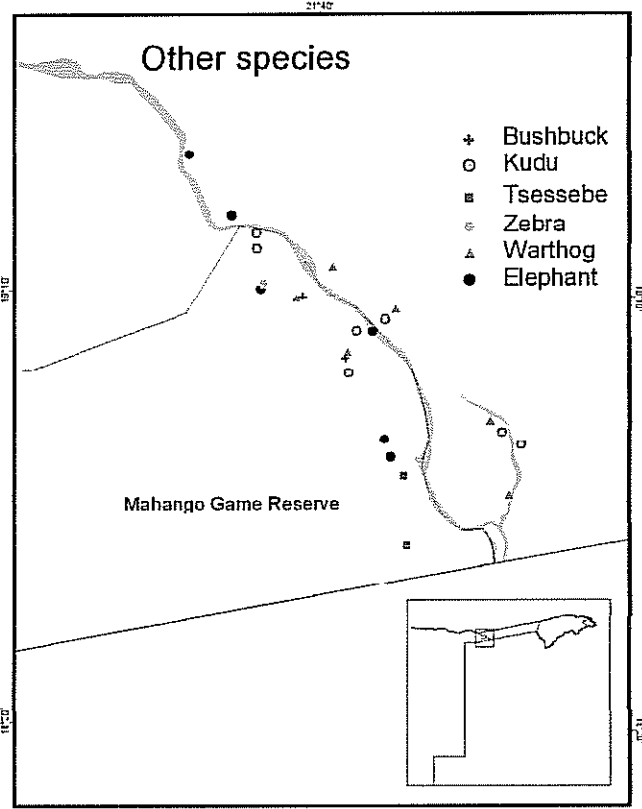
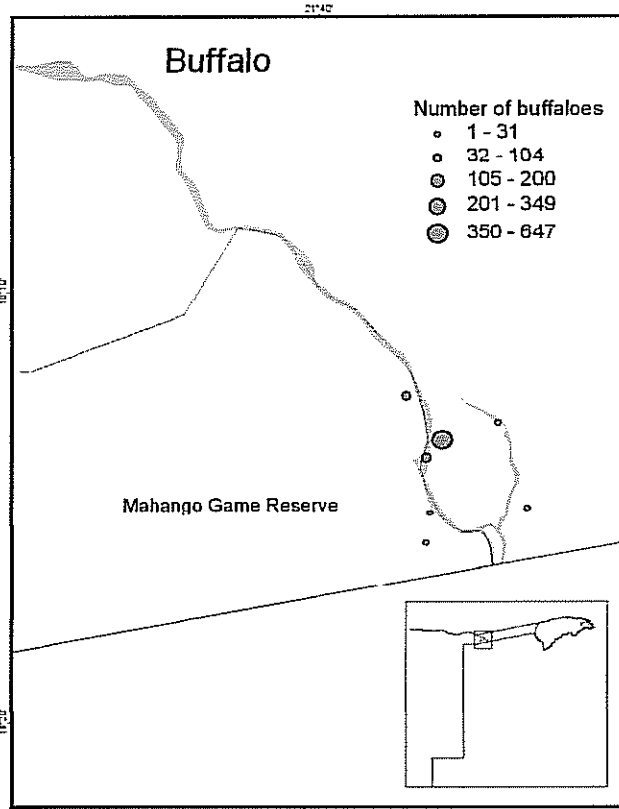
Distribution of water and flood plain species on the Kavango River





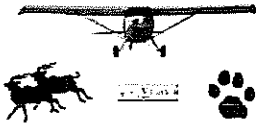
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Distribution of buffalo and other wildlife species on the Kavango River



Group sizes of wildlife species counted during the survey.

Species	Group size			N
	Average	Minimum	Maximum	
Baboon	16	3	35	10
Buffalo	59	1	647	55
Bushbuck	2	1	2	4
Crocodile	1	1	5	154
Elephant	8	1	112	106
Giraffe	3	1	5	8
Hippo	5	1	45	289
Impala	21	1	327	35
Kudu	6	1	30	16
Lechwe	7	1	56	106
Pelicans	50	1	240	10
Reedbuck	2	1	7	42
Sable	45	45	45	1
Sitatunga	2	2	2	1
Tsessebe	6	4	9	4
Warthogs	3	1	13	85
Waterbuck	5	1	23	11
Wattled Crane	2	2	2	4
Zebra	29	1	140	38

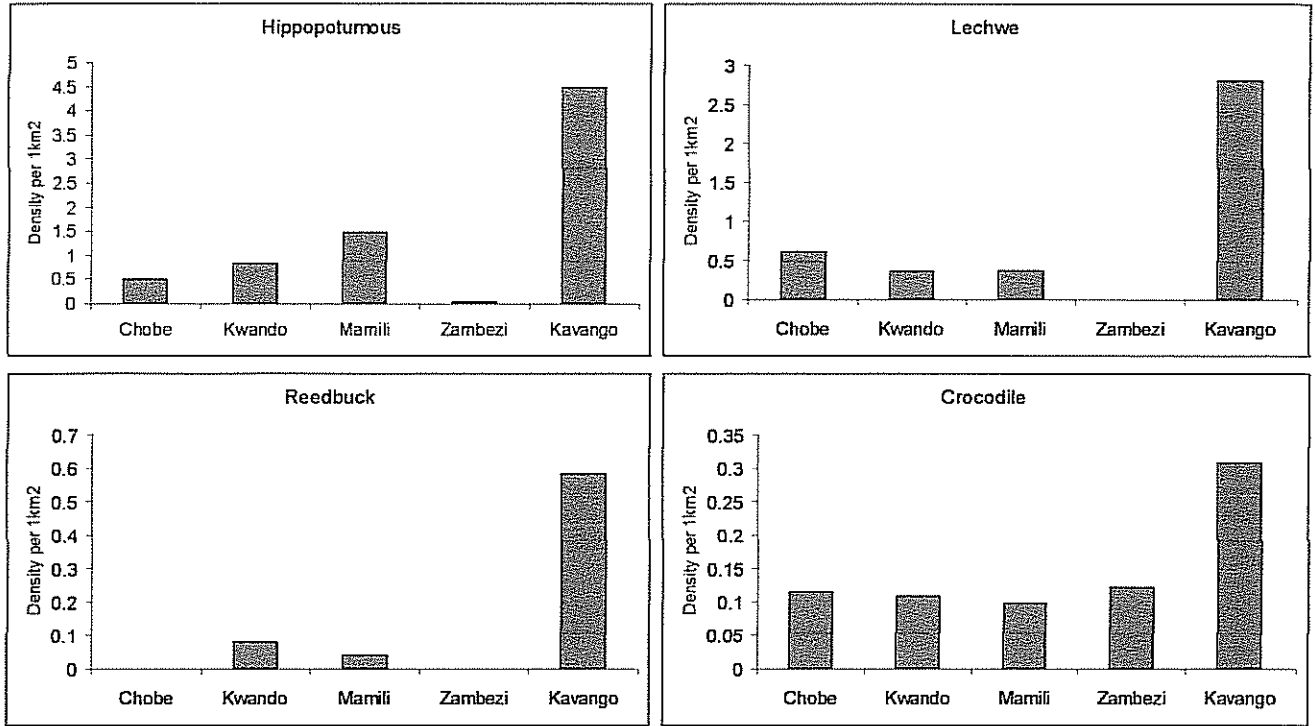


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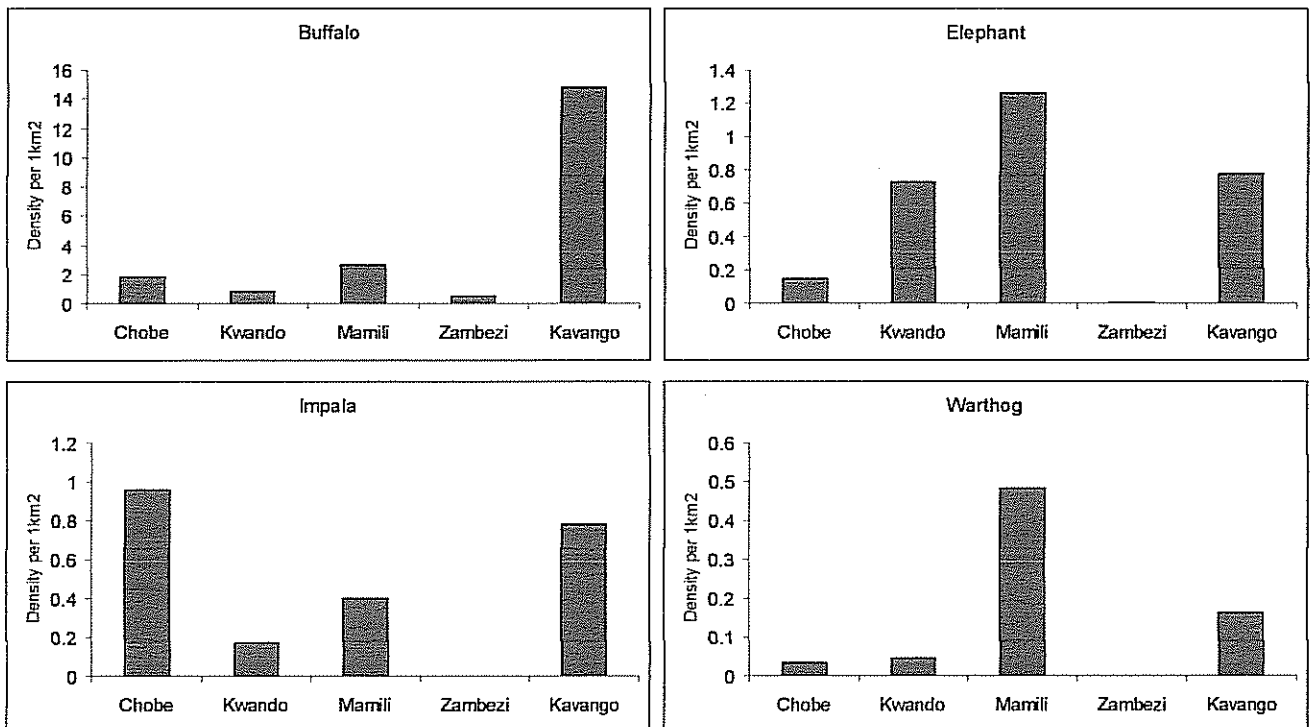
August 2004

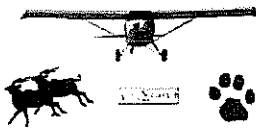
Variations in wildlife densities between Strata

The density (number of animals counted per km² surveyed) of water and flood plain species in the five different river and flood plain systems.



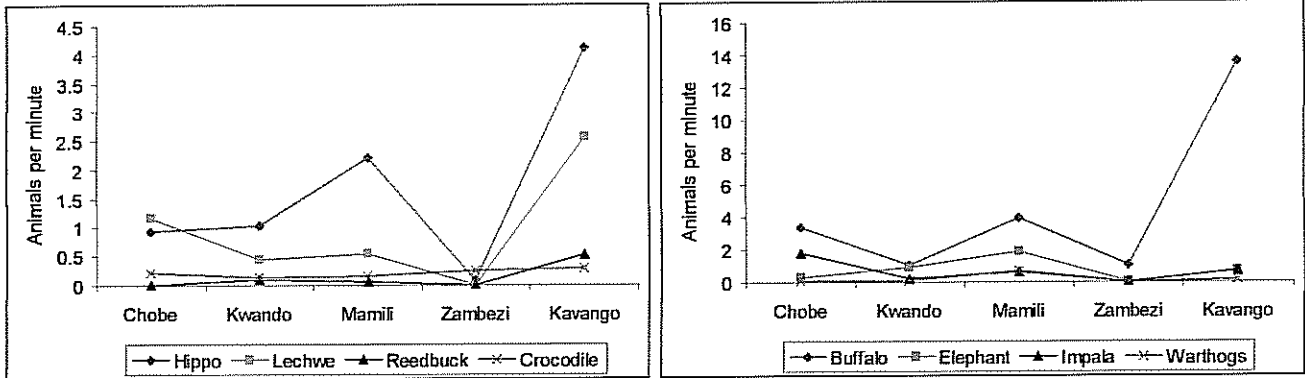
The density (number of animals counted per km² surveyed) of woodland and other wildlife species in the five different river and flood plain systems.





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The numbers of animals observed per minute in the five strata, expressed as a measure of relative abundance, indicate that, similar to the density graphs, wildlife numbers are high along the Chobe River, the Kavango River, and in the Mamili National Park.



Variations in wildlife densities in relation to land management systems.

It would appear that relatively higher densities of wildlife are associated primarily with protected areas. The distribution and density of wildlife is therefore also presented in relation to protected areas and communal conservancies.

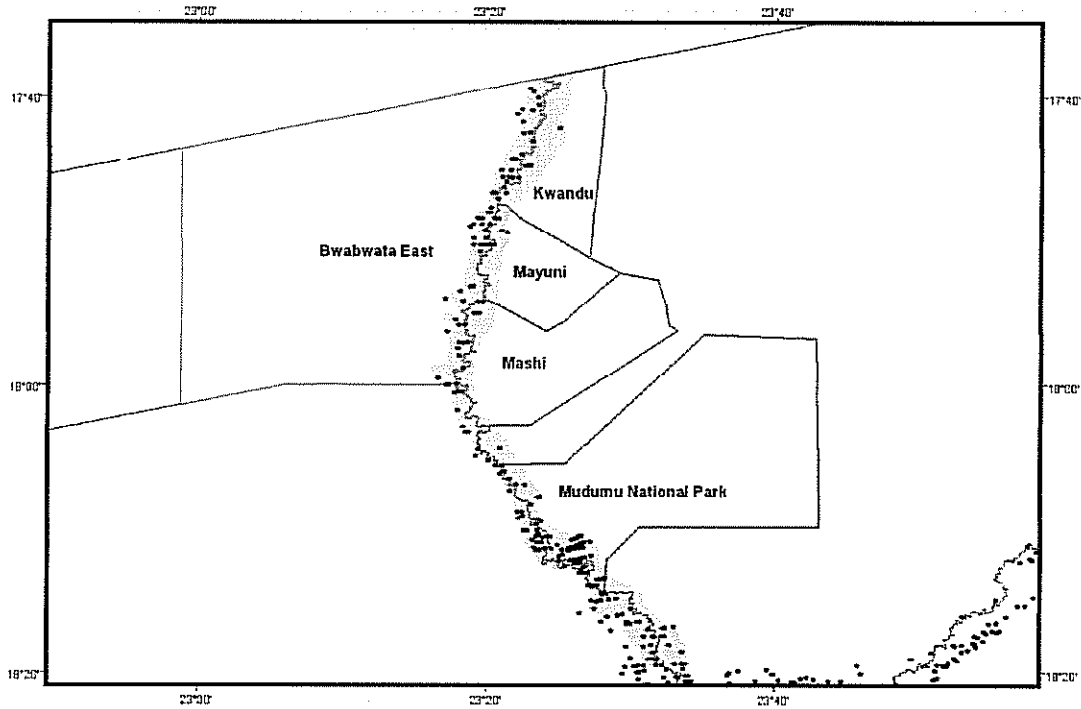
The size of area surveyed (km²) and wildlife numbers counted in 6 protected areas and 4 communal conservancies.

Protected areas	Area surveyed (km ²)	Water/flood plain species				Other common species			
		Hippo	Lechwe	Reedbuck	Crocodile	Elephant	Buffalo	Warthog	Impala
Bwabwata East	93.1	91	63	17	13		134		5
Bwabwata West	28.1	91	62	20	6	18	735	6	17
Mudumu NP	64.4	34	3	2	2	240	15	5	38
Mamili NP	376.6	560	137	15	37	473	993	182	150
Mahango GR	20.2	96	92	12	10	25	80	3	26
Chobe NP	53.6	184	258		27	44	660	15	112
Conservancies									
Kwando	52.8	8	16		8				
Mayuni	24.1	42	20						3
Mashi	28.7	18	1	1	4				
Salambala	41.5	1			1				77

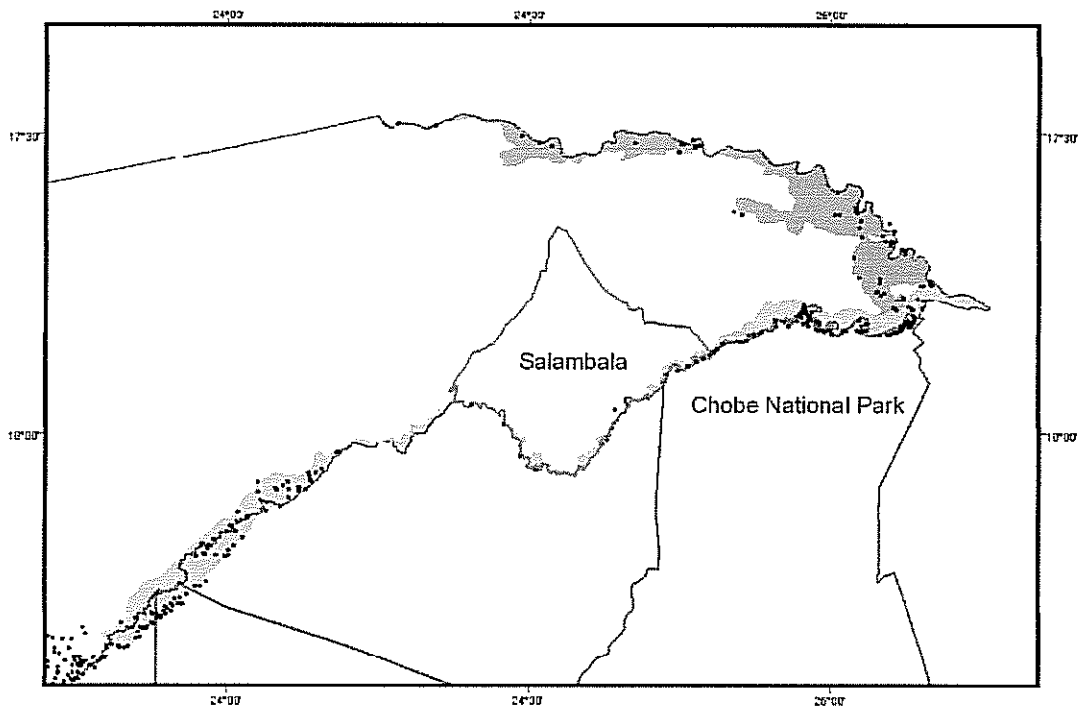


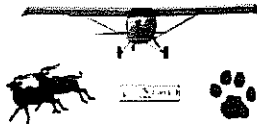
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Wildlife sightings in the Kwandu Stratum in relation to conservancies and protected areas



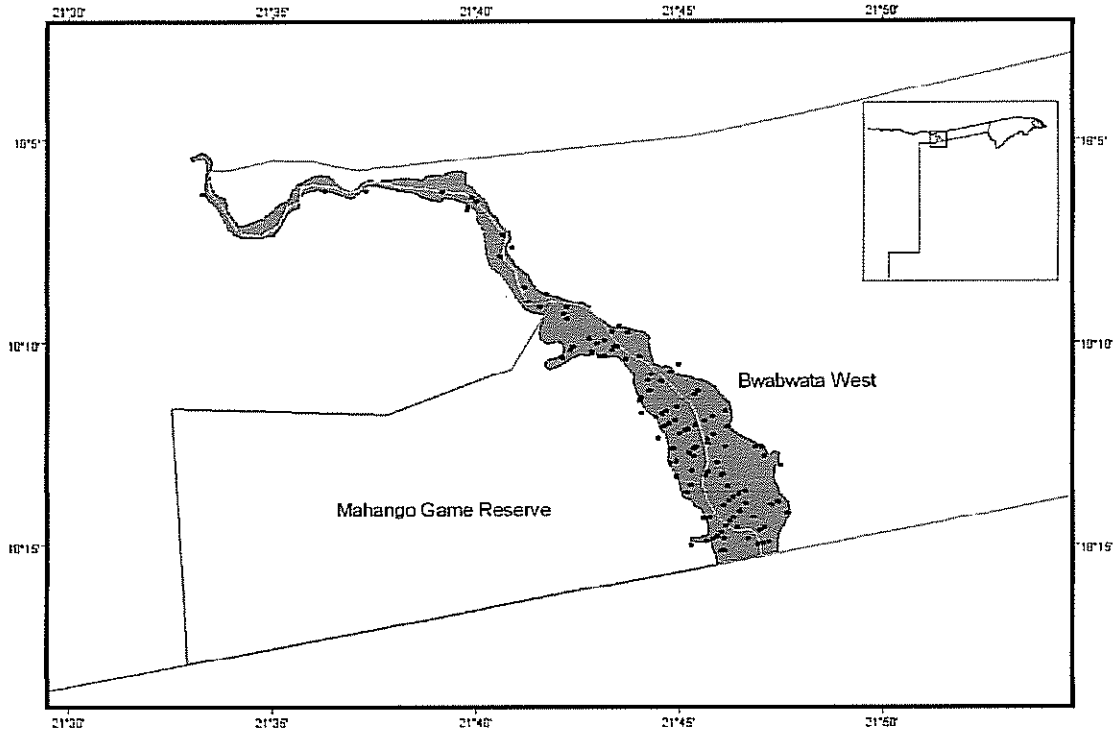
Wildlife sightings in the Linyanti/Chobe & Zambezi Strata in relation to conservancies and protected areas



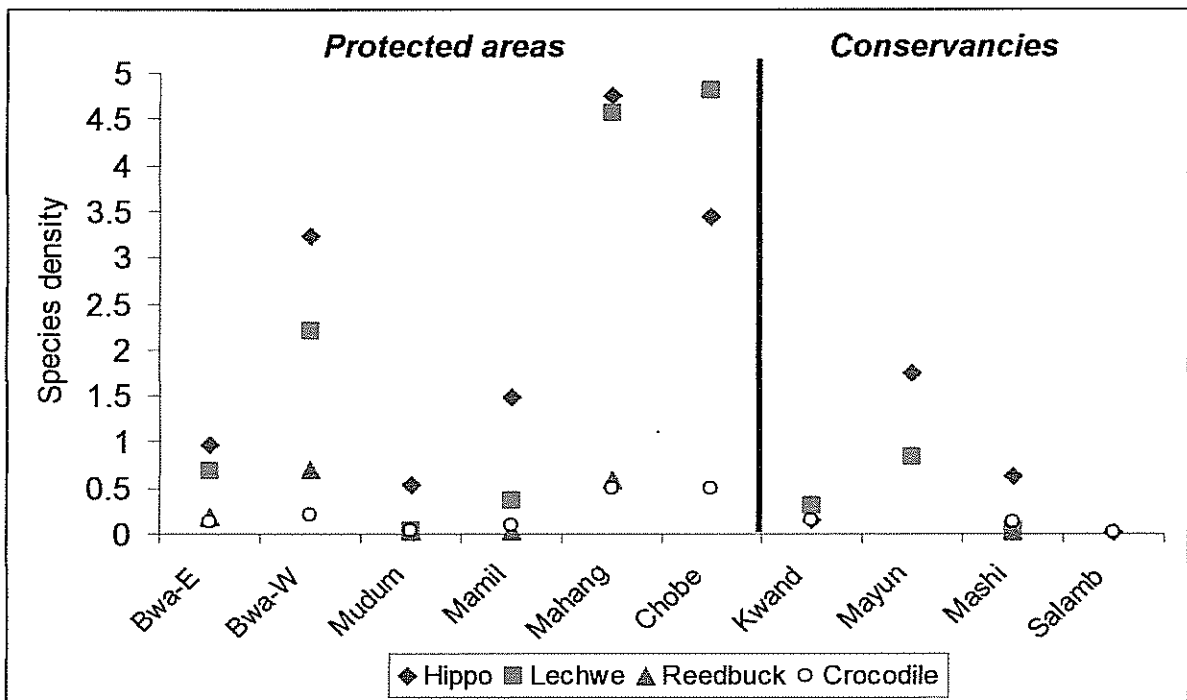


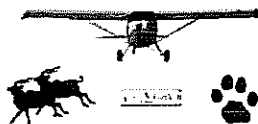
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Wildlife sightings in the Kavango Stratum in relation to the protected areas



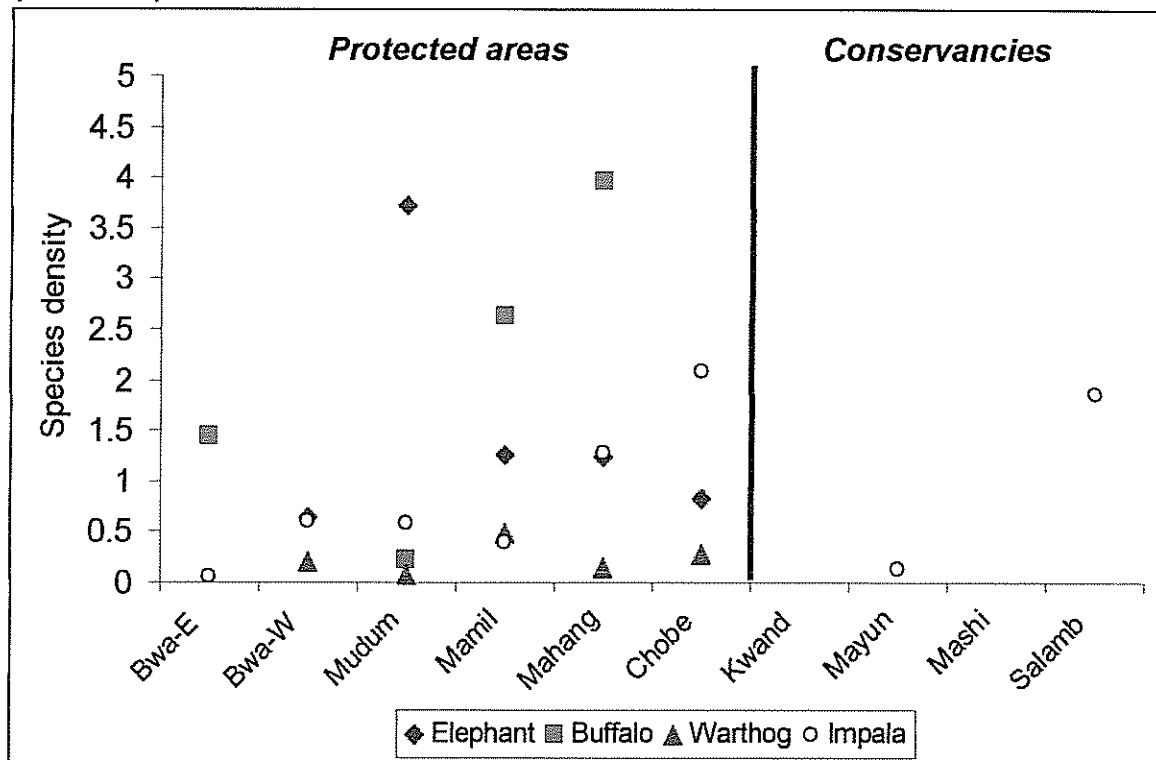
The density (number of animals counted per km² surveyed) of water and flood plain species in protected areas and conservancies.





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The density (number of animals counted per km² surveyed) of other common species in protected areas and conservancies.



The survey results indicate clearly that wildlife numbers are highest inside and close to the protected areas. The Mayuni Conservancy has slightly higher numbers of vulnerable lechwe on its floodplains than do other conservancies.

Survey effort and intensity

Successful aerial surveys are dependent on detailed planning, and precision and consistent flying patterns. It is therefore important to monitor these variables.

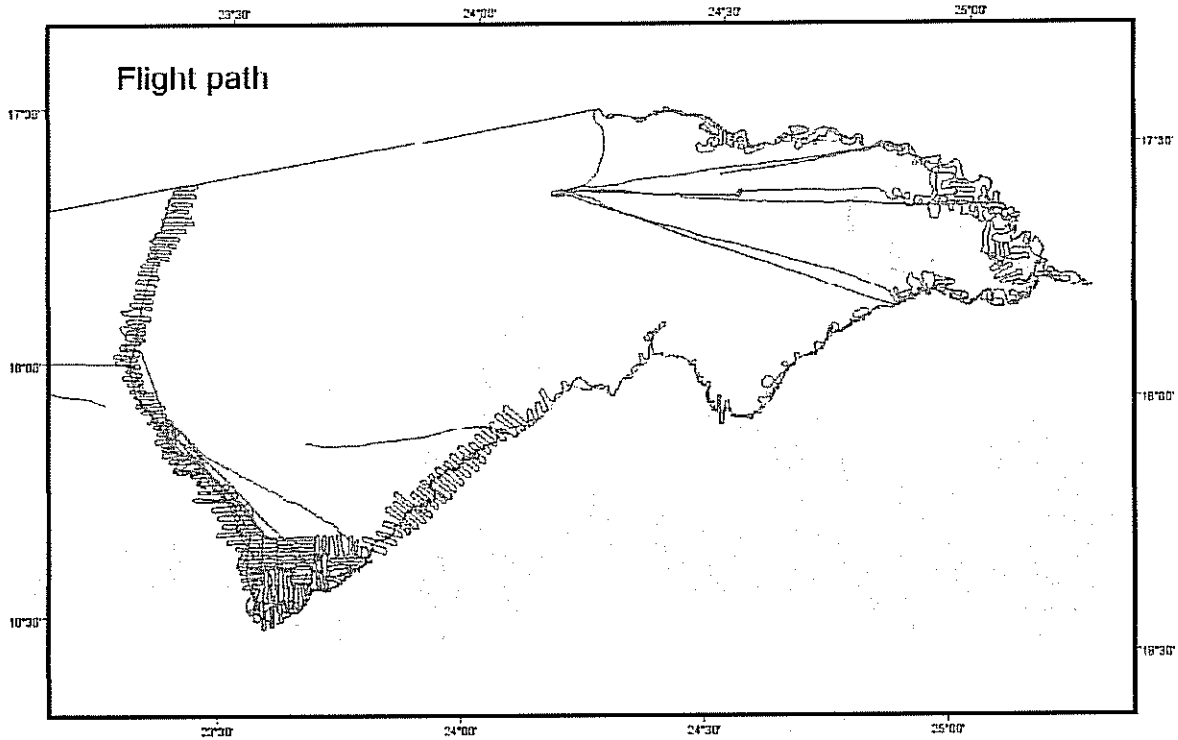
Survey and flying effort recorded for the five strata.

	Survey stratum				
	Linyanti/ Chobe	Kwando	Mamili NP	Zambezi	Kavango
Survey area (km ²)	506.1	369.9	376.6	454.6	55.4
Number of blocks	31	23	21	39	5
Flying time	7h 24m	5h 01m	4h 14m	3h 40m	1h
Search rate (km ² /min)	2.0	1.6	1.6	2.3	0.9
Mean survey height (ft)	304	260	255	256	283

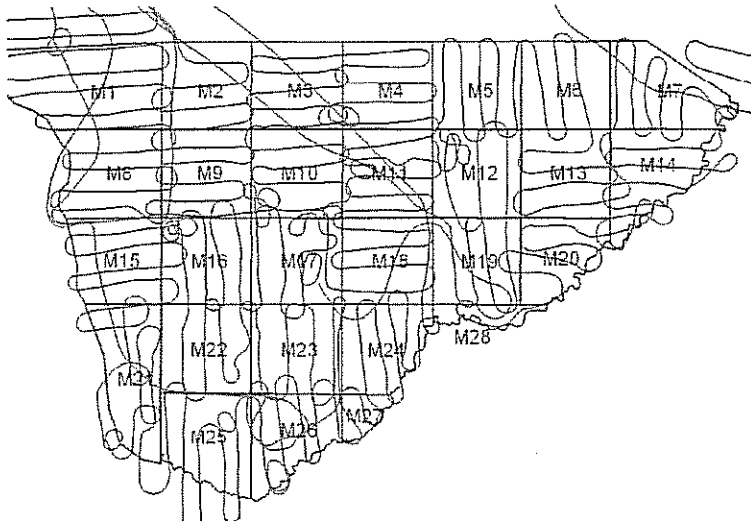


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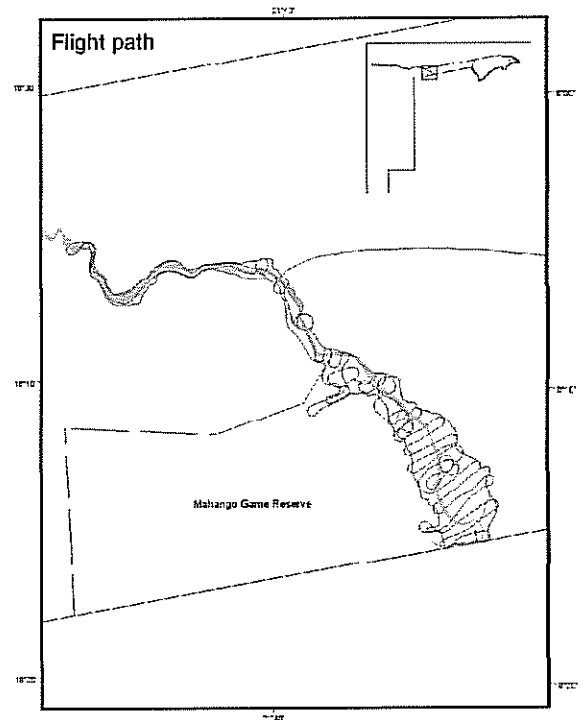
Recorded track logs of flight paths in the East Caprivi Strata, including Mamili NP.



Counting blocks in the Mamili Stratum
and the track log of flight paths



Recorded track logs of flight
paths in the Kavango Stratum



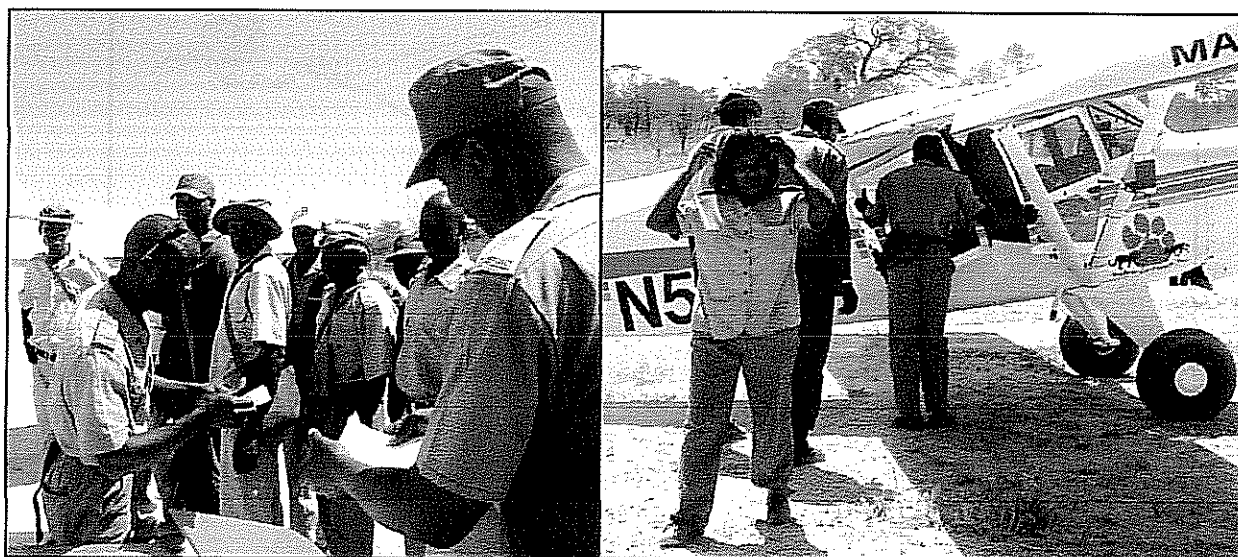


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Community training & feedback

Meetings were held with the local communal conservancies and Ministry of Environment and Tourism staff at the onset and closure of the survey. The communities received training on basic survey methodology, feedback on preliminary results, and eight members were given the opportunity to fly with the survey aircraft.



Patrick Haredoeb lecturing on survey techniques MET & conservancy staff on their maiden flights

Acknowledgements

We would like to thank Chris Brown, Jo Tagg and Pauline Lindeque for support and assistance during various stages of the survey. Lianshulu Lodge, and especially Ralph Meyer-Rust, are thanked for allowing us to use Lianshulu as a base, providing accommodation and meals, and being generally helpful and supportive throughout. Dick and Katy Sharp helped with accommodation at the "Fish Farm" in Katima Mulilo. Peter Hartmann, from Aviation Centre, went out of his way to repair the aircraft when it developed mechanical problems after the first flight.



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Appendix II Flight & survey records

Sorty	Date	am/pm	Route / Counting blocks	Start	End	Hr:Min	Min	Count	Ferry
1	10-Aug-04	am	Windhoek - Lianshulu			4:55	295	Nil	
2	11-Aug-04	am	W16-23	8:15:00	9:47:00	1:32	92	75	18.5%
3	14-Aug-04	pm	M2,9,10,3,4,11,18,17,16,22,23	13:17:00	15:31:00	2:14	134	99	26.1%
4	15-Aug-04	am	M19,5,6,12,13,7,14,20	5:33:00	7:19:00	1:46	106	70	34.0%
5	15-Aug-04	am	M28,24,21,15	8:17:00	9:42:00	1:25	85	58	31.8%
6	15-Aug-04	pm	M8,1,W23,22,23,21,20,18,17	13:50:00	15:45:00	1:55	115	94	18.3%
7	16-Aug-04	am	W1-13	5:47:00	8:06:00	2:19	139	108	22.3%
8	16-Aug-04	pm	W13-16	14:43:00	16:10:00	1:27	87	51	41.4%
9	17-Aug-04	am	C1-12	6:19:00	9:00:00	2:41	161	106	34.2%
10	17-Aug-04	pm	C13-21	13:17:00	15:18:00	2:01	121	82	32.2%
11	18-Aug-04	am	C22-31	5:46:00	7:41:00	1:55	115	84	27.0%
12	18-Aug-04	am	Z3,1,4,5,2,6,7,10	8:43:00	10:18:00	1:35	95	64	32.6%
13	18-Aug-04	pm	Z28-39	14:01:00	15:46:00	1:45	105	74	29.5%
14	19-Aug-04	am	Z9-27	5:27:00	7:36:00	2:09	129	82	36.4%
15	20-Aug-04	am	Community training			1:30	90	Nil	
16	20-Aug-04	pm	B1-5	12:37:00	15:52:00	3:15	195	60	69.2%
17	21-Aug-04	am	Return to Windhoek			2:10		Nil	
Totals for counting flights						27:59	1679	1107	34.1%
Totals for all flights						36:34	2194	1107	49.4%

Appendix III Counting blocks and flight details

The counting block IDs in each stratum, their area size (km²), time spent surveying the block (minutes), and the search/rate (km² per minute).

Stratum	Block	Area	Min	S/rate	Stratum	Block	Area	Min	S/rate	Stratum	Block	Area	Min	S/rate
Kwandu	W1	14.9	10	1.5	Chobe	C1	20.2	9	2.2	Zambezi	Z1	14.9	9	1.7
Kwandu	W10	17.4	10	1.7	Chobe	C10	20.0	7	2.9	Zambezi	Z10	16.2	11	1.5
Kwandu	W11	18.3	10	1.8	Chobe	C11	21.6	13	1.7	Zambezi	Z11	13.5	8	1.7
Kwandu	W12	14.0	6	2.3	Chobe	C12	50.1	24	2.1	Zambezi	Z12	5.0	4	1.2
Kwandu	W13	19.8	12	1.7	Chobe	C13	29.7	12	2.5	Zambezi	Z14	6.9	7	1.0
Kwandu	W14	21.1	14	1.5	Chobe	C14	11.8	6	2.0	Zambezi	Z15	7.8	3	2.6
Kwandu	W15	16.3	12	1.4	Chobe	C15	9.6	12	0.8	Zambezi	Z16	9.7	4	2.4
Kwandu	W16	18.9	13	1.5	Chobe	C16	6.9	7	1.0	Zambezi	Z18	10.7	3	3.6
Kwandu	W17	15.1	21	0.7	Chobe	C17	11.3	10	1.1	Zambezi	Z19	7.0	4	1.7
Kwandu	W18	14.9	8	1.9	Chobe	C18	12.1	4	3.0	Zambezi	Z2	13.7	5	2.7
Kwandu	W2	15.3	12	1.3	Chobe	C19	11.0	12	0.9	Zambezi	Z20	14.3	4	3.6
Kwandu	W20	15.9	8	2.0	Chobe	C2	18.0	8	2.2	Zambezi	Z21	14.4	5	2.9
Kwandu	W21	30.0	14	2.1	Chobe	C20	14.6	15	1.0	Zambezi	Z22	12.7	3	4.2
Kwandu	W22	22.0	19	1.2	Chobe	C21	14.0	4	3.5	Zambezi	Z23	9.4	3	3.1
Kwandu	W23	17.4	12	1.5	Chobe	C22	15.9	12	1.3	Zambezi	Z24	14.5	4	3.6
Kwandu	W3	15.3	10	1.5	Chobe	C23	13.8	8	1.7	Zambezi	Z25	11.2	5	2.2
Kwandu	W4	15.7	8	2.0	Chobe	C24	15.9	11	1.4	Zambezi	Z26	12.6	6	2.1
Kwandu	W5	17.3	10	1.7	Chobe	C25	14.2	8	1.8	Zambezi	Z27	9.0	6	1.5
Kwandu	W6	17.0	14	1.2	Chobe	C26	15.8	5	3.2	Zambezi	Z28	5.9	5	1.2
Kwandu	W8	16.4	9	1.8	Chobe	C27	16.6	9	1.8	Zambezi	Z29	4.8	5	1.0
Kwandu	W9	16.8	9	1.9	Chobe	C28	15.2	8	1.9	Zambezi	Z3	23.2	12	1.9
Mamili	M1	23.3	15	1.6	Chobe	C29	17.7	10	1.8	Zambezi	Z30	11.7	4	2.9
Mamili	M10	14.3	9	1.6	Chobe	C3	14.4	7	2.1	Zambezi	Z31	14.2	4	3.5
Mamili	M11	14.2	10	1.4	Chobe	C30	15.6	6	2.6	Zambezi	Z32	18.3	6	3.1
Mamili	M12	14.0	9	1.6	Chobe	C31	19.9	7	2.8	Zambezi	Z33	8.1	7	1.2
Mamili	M13	14.0	8	1.8	Chobe	C4	14.7	7	2.1	Zambezi	Z34	17.1	10	1.7
Mamili	M14	13.7	11	1.2	Chobe	C5	13.0	7	1.9	Zambezi	Z35	15.0	5	3.0
Mamili	M15	13.5	11	1.2	Chobe	C6	10.5	5	2.1	Zambezi	Z36	13.1	4	3.3
Mamili	M16	14.0	9	1.6	Chobe	C7	11.3	6	1.9	Zambezi	Z37	12.5	6	2.1
Mamili	M17	14.2	13	1.1	Chobe	C8	11.6	5	2.3	Zambezi	Z38	7.8	12	0.6
Mamili	M18	14.1	8	1.8	Chobe	C9	18.9	8	2.4	Zambezi	Z39	9.2	6	1.5
Mamili	M19	13.8	7	2.0	Kavango	K1	11.6	11	1.1	Zambezi	Z4	14.6	8	1.8
Mamili	M2	13.9	5	2.8	Kavango	K2	13.7	12	1.1	Zambezi	Z5	14.4	5	2.9
Mamili	M20	10.6	7	1.5	Kavango	K3	9.1	11	0.8	Zambezi	Z6	12.1	6	2.0
Mamili	M21	15.1	16	0.9	Kavango	K4	9.6	15	0.6	Zambezi	Z7	20.9	8	2.6
Mamili	M22	14.3	6	2.4	Kavango	K5	11.4	11	1.0	Zambezi	Z8	14.4	9	1.6
Mamili	M23	14.5	10	1.4	Mamili	M28	3.3	3	1.1	Zambezi	Z9	13.9	4	3.5
Mamili	M24	12.2	12	1.0	Mamili	M3	14.2	9	1.6	Mamili	M5	13.9	10	1.4
Mamili	M25	14.3	11	1.3	Mamili	M4	14.0	11	1.3	Mamili	M6	13.9	5	2.8
Mamili	M26	12.3	8	1.5	Mamili	M7	14.6	10	1.5	Mamili	M9	14.1	9	1.6
					Mamili	M8	15.4	12	1.3					



Aerial Survey of Caprivi River Systems

August 2004

Appendix I Survey images



Examples of digital photo images used to count large groups

