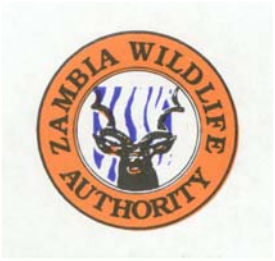

AERIAL CENSUS OF ELEPHANTS AND OTHER LARGE HERBIVORES IN SOUTH LUANGWA NP & LUPANDE GMA, ZAMBIA: 2002

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SUMMARY

Elephants and other large herbivores, wild and domestic, in South Luangwa National Park and Lupande Game Management Area, Zambia, were surveyed from the air during the period 12-19 August 2002. The area surveyed totalled 13 407 km^2. The overall sampling intensity was 8.3 %. The mean search intensity was 0.98 minutes per square kilometre.

The survey was designed to estimate the number of elephants. Some large herbivores are not easily seen from the air and their numbers were undoubtedly underestimated. Nonetheless, population estimates are given for these species, because the estimates provide useful indices of abundance (with measures of precision) that can be used to determine spatial distribution, as well as temporal trends in population number. No corrections have been applied to any of the estimates to compensate for any undercounting or missed animals.

The estimated population numbers of the principal large herbivores were: elephant 5434 (95% confidence interval (CI) 30.5 %); impala 11 814 (CI 30 %); buffalo 9306 (CI 90 %); puku 5659 (CI 44 %); zebra 3250 (CI 30 %); roan antelope 632 (CI 84 %); waterbuck 575 (CI 48 %); kudu 505 (CI 71 %); Lichtenstein's Hartebeest 283 (71 %); Thornicroft's giraffe 236 (CI 61 %); reedbuck 225 (CI 63 %); eland 202 (CI 96 %); and sheep and goats 1175 (CI 81 %). The sheep and goats were confined to the Lupande GMA.

The mean carcass ratio for elephants was 1.3 %. There were an estimated 60 (CI 74 %) poachers' camps in South Luangwa NP.

A comparison of the sighting rates of the two observers revealed that one observer saw significantly less animals than the second observer: if the two observers had seen animals at the same rate, the estimated number of elephants would have been 28.5% greater than the above figure. Estimates for most other species would also have been greater.

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INTRODUCTION

Large wild and domestic herbivores were censused during August 2002 in the central Luangwa Valley, Zambia, as part of the background to a land-use study in the Lupande Game Management Area (GMA).

METHODS

Survey Area

The survey area covered 13407 km^2 and was divided into 14 strata (see Map 1 and Table 1). The survey area included South Luangwa National Park (SLNP) and Lupande GMA.

The strata boundaries were generally similar to those used during the 1999 survey (Jachmann & Phiri 1999), as determined after examination by the authors of the survey maps held in the Lusaka offices of the Wildlife Resource Monitoring Unit of the Environmental Council of Zambia. These survey maps showed the survey boundaries for the GMAs, but not for SLNP. The same maps had been used for several surveys during different years and the strata boundaries often varied between years. Hence, it was often not easy to determine which boundaries were used during 1999. Consequently, there may be minor variations between the boundaries of survey strata used during 1999 and those used during 2002. The provision of information on the abundance and distribution of wildlife in Lupande GMA was a major aim of the 2002 survey and so almost the entire GMA was surveyed during 2002, although only 1500 km^2 of this GMA was surveyed during 1999.

In the south-west of SLNP, 166 km^2 between the lip of the Muchinga Escarpment (which here is the park boundary) and the base of the escarpment was not surveyed during 2002, because this could not be done safely over this rapidly-rising ground with the survey technique used here. A small area (146 km^2) of hilly ground in the south-east of Lupande GMA (to the south of the East Lupande stratum) was also excluded from the survey.

Strata boundaries were digitised from 1:250 000 scale maps purchased from the Surveyor General's Department in Lusaka. A digital file containing the co-ordinates (in decimal degrees latitude and longitude) of the boundaries of the strata was converted into bna-format that could be used by the WWF software for designing aerial surveys. The bna file was imported into the CARTALINX software (Hagan, Eastman & Auble 1998) and the area of each stratum determined.

The total area of SLNP (i.e. the sum of the areas of eight strata, numbers 1 to 8, and the unsurveyed 166 km^2) was calculated as 8614 km^2, which compares with 9050 km^2, which is the official estimate of the park's area and the area used by Jachmann & Phiri (1999) in their analysis. This difference of 436 km^2 is in agreement with Astle's (1999, p.116) observation that the official estimate of the size of SLNP appears to overestimate the true size by about 300 km^2. There was also a discrepancy between Jachmann & Phiri's (1999) estimate of the area of Lupande GMA (4500 km^2), the area stated in Statutory Instrument 174 (4840 km^2 (Astle 1999)) and the area calculated by us from the digitised boundaries shown on 1:250 000 scale maps (5106 km^2).

In order to reduce the potential for observer fatigue during flights, transect lengths were reduced (cf. previous surveys in this area) by dividing the portion of SLNP that lies to the west of the Luangwa River into six strata. The boundaries between strata were chosen so as to minimise the heterogeneity of elephant density within individual strata, as determined by visual inspection of a map of elephant distribution within SLNP during the dry seasons of

1993-1999 (Jachmann & Phiri (1999, Figure 20)).

Survey Design

The procedures used followed those well established for aerial surveys of African large herbivores (Norton Griffiths 1978) and utilised during earlier surveys of large herbivores in Zambia.

Systematic, parallel transects were positioned across each stratum. Transects were arranged approximately at right angles to the principal environmental feature within a stratum (see Map 1 and Table 1 for transect orientations). The distance between adjacent transects varied between strata, according to the planned sampling intensity in each stratum. Overall sampling intensity was planned to be about 8 %. The planned sampling intensity in each stratum was determined by using the mean of the elephant densities in each stratum during 1998 and 1999 when these were known (Jachmann & Phiri 1999) as the predicted elephant densities in equation 1 of Gibson (1992). Absolute elephant densities in the strata within SLNP were not known, but relative density estimates were provided by Jachmann & Phiri's map of elephant distribution during previous surveys. East Lupande stratum and Machinje stratum, both in Lupande GMA, were expected to contain few elephants. The Lupande Hills reportedly contained significant numbers of wildlife (M. Jones, pers. comm.) and so sampling intensity was relatively high in this stratum.

As a consequence of these procedures, those strata expected to contain large numbers of elephants were sampled more intensively than strata expected to contain few elephants. The transect spacings used are given in Table 1.

Surveys were designed using WWF's custom software (AIRDESW, version dated 29/05/97). Given a stratum boundary in the form of a bna file, and the transect orientation and spacing, this software generated flight lines (the transects), with the first flight line offset from the end of the stratum by the random number entered as the "offset". The start and end points for each transect were transferred as waypoints to a GPS receiver in the plane prior to flying each stratum.

Flight Procedure

The aircraft used was a Cessna 206. It was fitted with a radar altimeter and a Trimble GPS100 GPS receiver. During surveys, the aircraft was flown at approximately 160 km per hour at about 300 feet above ground level. The actual height above ground level (agl) was recorded from the radar altimeter every 30 seconds (of time) while flying along transects and later the mean height above ground level was calculated for each transect. Navigation along the transects was undertaken by the pilot, with reference to the GPS receiver and its course deviation indicator.

The aircraft crew included a pilot (Jon Cadd), a recorder (Hopeson Simwanza) who sat next to the pilot, and two observers (Paul Zyambo and Wilfred Moonga) who sat behind the pilot and recorder. Both observers had previous experience of observing during aerial surveys. All four crew could talk to one another through an intercom system.

All animals seen by the observers within the strips (see section *Strip Width and Calibration* below) were called to the recorder, who wrote down the species, the number of individuals of the group that were within the strip, and the GPS location against the time (to the nearest 30 seconds) after the start of the transect. Location was recorded as longitude when flying north-

south and as latitude when flying east-west. The recorder used a stopwatch to record the time (to the nearest second) taken to fly each transect.

Although the survey was designed especially to count elephants, all wild herbivores larger than impala were counted, together with domestic cattle, sheep, goats, pigs and donkeys. Sheep and goats could not be distinguished from the air and were lumped together as "sheep and goats". It is not always easy to differentiate between impala and puku from the air and possibly these two species were confused occasionally by observers.

During the survey, groups of elephant bulls were differentiated from elephant cow herds, although the latter may have included some bulls. Elephant carcasses were recorded and classified as:

Carcass category	Definition
1	**Fresh**: intact; white droppings of vultures visible; vegetation trampled; fluid stain on ground around carcass visible (animal likely to have died within the last 3 months).
2	**Recent**: pieces of hide still attached; skeleton still partly articulated; no vulture droppings; no trampled vegetation; no fluid stain evident (less than 1 year old, but generally since the last rainy season, i.e. 3 to 8 months old).
3	**Old**: bones scattered and bleached (probably died during or before the last rainy season, i.e. more than 8 months old but generally more than 1 year old and up to several years old).

The carcass "ratio", *sensu* Douglas-Hamilton, Michelmore & Inamdar (1992), (although it is not a ratio, but a percentage) was calculated as the estimated number of all elephant carcasses (i.e. age categories 1, 2 and 3) as a percentage of the estimated number of all elephants (i.e. live + dead). Carcasses that could not be identified as elephant carcasses were recorded as "unidentified carcasses".

Ground hornbills are large and conspicuous birds and any seen during the survey were recorded.

Poachers' camps were also recorded. They were identified by the presence of meat racks (horizontal branches mounted above the ground), with or without meat, or meat hanging in trees.

Some large herbivores, e.g. kudu, are not easily seen from the air and their numbers were undoubtedly underestimated. Nonetheless, population estimates are given for these species, because the estimates provide useful indices of abundance (with measures of precision) that can be used to determine spatial distribution, as well as temporal trends in population number. No corrections have been applied to any of the estimates to compensate for any undercounting or missed animals.

All strata were flown during the period 12 - 19 August 2002 (Table 1).

Strip Width and Calibration

Two fishing rods were attached with custom brackets to each wing strut, so that the rods pointed backwards and parallel to the ground during level flight. The distance between the rods on each strut was arranged so that, when the aircraft was flying at 300 feet above ground level, the distance represented a strip about 150 m wide on the ground. Each rod was marked with a small piece of tape to provide the observers with a "decision point" (it was at this point that the observer decided whether an animal was inside the strip).

The strip widths were calibrated by flying the aircraft at right angles across a disused airstrip that had two sets of large-sized numbers (from 1 to 35) arranged at 10 meter intervals along the length of the airstrip. The numbers were arranged as 35, 34, 33 ….1, 0, 1, …..33, 34, 35, with 0 near the centre of the airstrip. Each observer noted the largest and smallest number within his strip and the recorder noted the aircraft's height, which varied between 250 and 350 feet.

The nominal combined strip width at 300 feet agl was determined by averaging the combined strip widths, after adjusting these to 300 feet agl (see Appendix 1 for data and calculations).

Data Analysis

Population estimates and confidence intervals for individual strata were calculated with WWF's custom software (AIRSURVW, version dated 22/05/97), which uses Jolly's (1969) method 2 for unequal-sized sample units. Given the combined strip width when the plane was flying at 300 feet agl, and the mean height agl for each transect, the software determined the actual combined strip width for each transect. The area of each transect was calculated as the product of the actual combined strip width and the transect length (provided by AIRDESW). Search intensity (in minutes km^{-2}) for a stratum was defined as the total time spent flying all transects within that stratum, divided by the total area of those same transects. The greater the search intensity, the greater the probability that observers observed animals that were within the strips.

Transects near the boundary of a stratum were often broken into two or more sections, with land outside the stratum between the sections. For the purposes of analysis, data for all sections of the same transect were combined and entered into the program as one transect. The value of Student's *t* entered in the program to calculate the confidence interval was t_{n-1} for $P = 0.05$ (Rohlf & Sokal 1981), where n = number of transects in stratum.

Population estimates for SLNP, Lupande GMA and the entire study area were calculated as the sum of the estimates for the strata within each of these three land units. The confidence interval for each population estimate for the entire study area, for SLNP and for Lupande GMA was calculated as:

t_v . □(Sum of Variances)

where:

v = the degrees of freedom estimated by Satterthwaite's rule (Gasaway *et al*. 1986).

i.e.

v = (Sum of Variances)^2 / Sum of [(Variance for individual stratum)^2 / (n-1)].

RESULTS

The estimated numbers of elephants, elephant bulls in bull groups, elephants in cow herds, old carcasses (category 3) of elephants, unidentified carcasses, buffalo, eland, Thornicroft's giraffe, Lichtenstein's hartebeest, impala, kudu, reedbuck, roan antelope, warthog, waterbuck, Cookson's wildebeest, warthog, zebra, ground hornbill, sheep and goats, and poachers' camps is given in Tables 3 to 23. Estimates are given for each stratum and for the entire survey area. Separate estimates are provided for South Luangwa National Park and Lupande GMA. Confidence intervals (CI) and confidence limits (CL) are 95 % confidence intervals and limits. "No. seen" is the number seen in the strips during the survey. There may appear to be small errors in the sums given at the foot of some tables: these are rounding errors: estimates, variances and sums were calculated with great precision in a spreadsheet, before being rounded to zero decimal places. A summary of the population estimates and sampling statistics for the survey is given below.

Small numbers of lion, bushbuck, common duiker and domestic pigs were seen during the survey, but no attempt has been made to estimate the numbers of these species. No fresh (category 1) or recent (category 2) carcasses of elephants were seen. No domestic cattle or donkeys were seen.

The spatial variation in the density of the principal wildlife species within the survey area is shown in Maps 2 to 16.

Summary Table: Population estimates and statistics for large mammals, ground hornbills, carcasses and poachers' camps in South Luangwa NP and Lupande GMA

Species / Object	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
Elephant	5434	596	690362	30.5	3775	7093	0.41
Buffalo	9306	1091	16814949	90.1	920	17692	0.69
Eland	204	24	8839	95.7	9	399	0.02
Thornicroft's Giraffe	236	27	5139	61.0	92	379	0.02
Lichtenstein's Hartebeest	283	26	9220	70.7	83	484	0.02
Impala	11814	1330	2984060	29.5	8330	15299	0.88
Kudu	505	46	30559	70.6	148	861	0.04
Puku	5659	623	1185579	44.4	3149	8170	0.42
Reedbuck	225	24	4860	62.6	84	365	0.02
Roan Antelope	632	42	58195	84.1	101	1163	0.05
Waterbuck	575	63	19214	48.1	298	852	0.04
Cookson's Wildebeest	527	41	284365	280.8	0	2008	0.04
Warthog	1129	120	36853	34.1	744	1514	0.08
Zebra	3250	373	231737	30.0	2275	4226	0.24
Ground Hornbill	457	37	17301	59.2	187	728	0.03
Sheep & goats	1175	52	205567	81.1	222	2127	0.09
Elephant carcasses	71	5	1827	130.4	0	163	0.01
Unidentified carcasses	36	4	286	94.9	2	71	0.003
Poachers' camps	60	7	489	74.1	15	104	0.004

DISCUSSION

Elephant Carcasses

Carcass "ratios" of 2-8 % are regarded as indicative of elephant populations that are stable or increasing in number, while "ratios" greater than 8 % suggest that population number is declining (Douglas-Hamilton *et al*. 1992). The "ratio" in this study area was low, with a mean for the entire study area of 1.3 %. The "ratio" varied from 0.5 % in SLNP to 4.9 % in Lupande GMA.

Comparison between observers

The right observer, despite searching a narrower strip than the left observer, saw more groups and more individuals of most species than did the left observer (Table 2). If the two observers had seen similar densities of elephants in their search strips, the estimate of the number of elephants in the study area would be 28.5 % greater than that calculated in Table 3. The estimated populations numbers of most other species would also greater by the factors given in Table 2.

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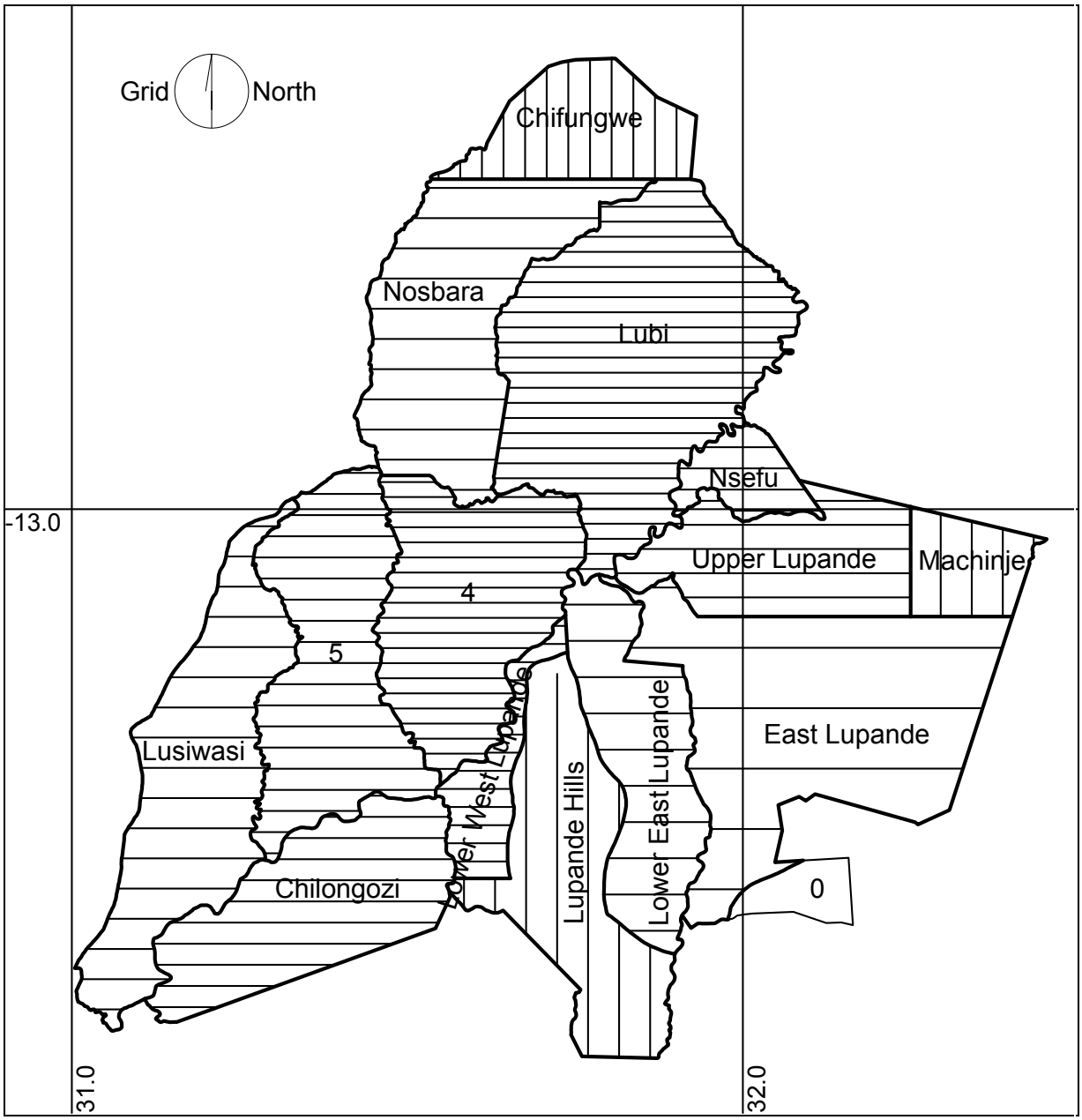


Map 1. The survey area in the central Luangwa Valley, Zambia.
Strata names, strata boundaries (bold lines) and transects (thin, parallel lines) are shown. A small section of hilly terrain in Lupande GMA (0) was not surveyed.

Table 1: Sampling statistics for the 2002 aerial survey of elephants and other large herbivores in the central Luangwa Valley

Stratum number and name	Area (km^2)	Transect spacing (km)	Transect orientation (°)	Number of transects (= *n*)	Percent of stratum sampled	Time and Date sampled	Hours flown			Search intensity (mins km^{-2})
							Transects	Stratum	Total [1]	
South Luangwa National Park										
1 Chifungwe	556	3.5	0	12	9.09	am 13/8	0.83	1.22	3.73 [a]	0.98
2 Nosbara	1222	5.0	90	11	6.62	am 13/8	1.31	1.78	[a]	0.97
3 Lubi	1961	2.5	90	27	13.14	am & pm 14/8	4.14	5.45	6.55	0.96
4 Stratum Four	1128	2.5	90	21	13.02	am & pm 15/8	2.38	2.87	4.77 [b]	0.97
5 Stratum Five	1127	3.5	90	19	9.31	am 17/8	1.78	2.62	3.35	1.02
6 Lusiwasi	1224	5.0	90	17	6.53	am 19/8	1.37	2.02	3.07	1.03
7 Chilongozi	1004	3.5	90	11	9.39	am 18/8	1.50	1.92	[d]	0.96
8 Nsefu	226	3.5	90	5	9.80	pm 18/8	0.41	0.68	1.23	1.12
Lupande Game Management Area										
9 Upper Lupande	765	4.0	90	5	7.75	pm 17/8	1.00	1.28	[c]	1.01
10 West Lower Lupande	274	3.0	90	14	10.39	am 15/8	0.45	0.85	[b]	0.95
11 East Lower Lupande	816	6.0	90	10	5.40	pm 13/8	0.74	1.17	1.55	1.01
12 Machinje	295	5.0	0	4	5.43	pm 17/8	0.26	0.38	2.28 [c]	0.97
13 East Lupande	1797	10.0	90	6	3.23	pm 12/8	0.89	1.28	1.63	0.92
14 Lupande Hills	1012	5.0	0	7	6.99	am 18/8	1.07	1.47	4.33 [d]	0.91
Total	**13407 km^2**			**Overall**	**8.31 %**				**Mean**	**0.98**

1 Strata with the same superscript were surveyed during the same flight

Table 2: Number of groups and animals of the major species seen by the two observers, and the number of groups that they would be expected to have seen if they were equally efficient at spotting animals from the plane.

The left observer searched a strip 171 m wide and the right observer searched a strip 147 m wide. Hence, the number of groups of a given species that a particular observer was expected to have seen was calculated as:

(Total number of groups of that species seen by both observers) x (Given observer's strip width) / (Left strip width + Right strip width)

Each chi-squared value is for a test comparing observed and expected numbers of groups for the given species and has 1 degree of freedom.

The multiplication factor is a number which, when multiplied by the calculated population estimate (Tables 3 and onwards), reveals what the population estimate would have been if both observers had found animals, in their search strips, at the same density as the right observer did. The multiplication factor for each species was calculated as:

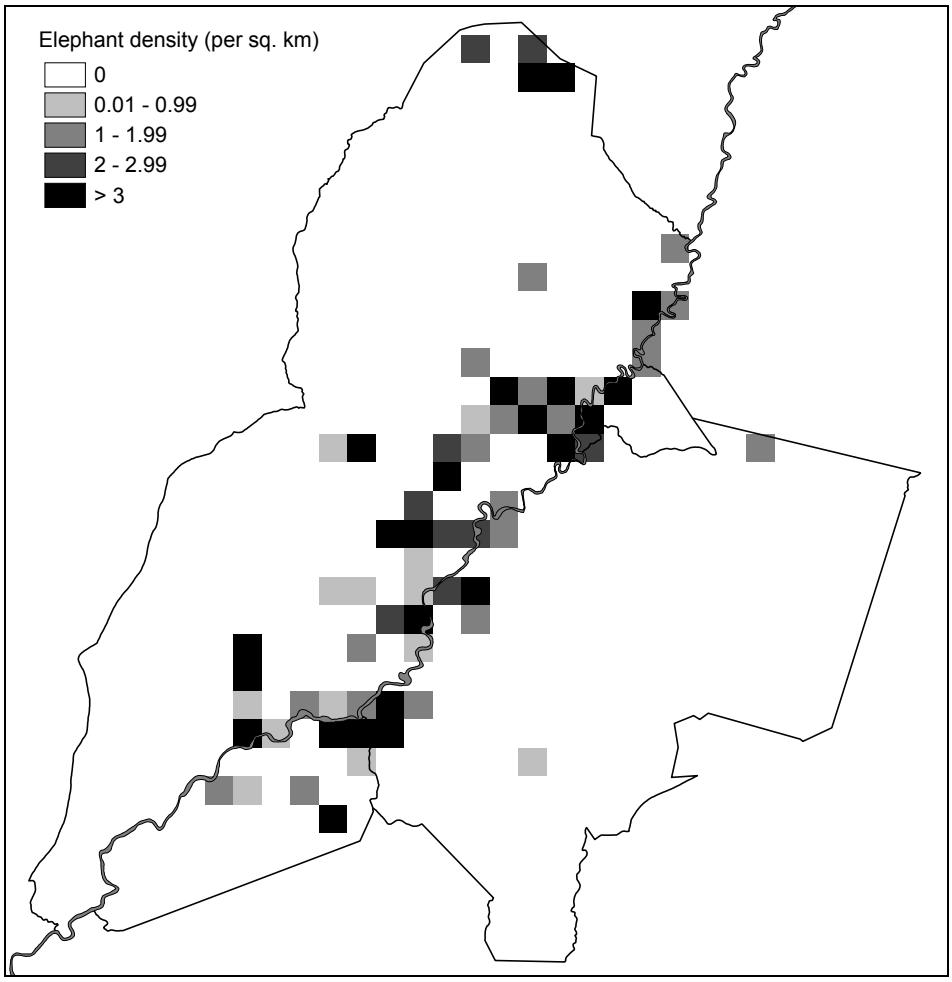
[(Left strip width + Right strip width) / Right strip width] x (Number of animals seen by right observer) / (Total number of animals seen by both observers)

Species	**Left Observer**			**Right Observer**			χ^2	***P*** (NS = Not Significant)	**Multiplication factor**
	Number of animals observed	Number of groups observed	Number of groups expected	Number of animals observed	Number of groups observed	Number of groups expected			
Buffalo	314	14	17	777	17	14	1.17	NS	1 [a]
Eland	19	5	3	5	1	3	2.667	NS	1
Elephant	242	43	61	354	71	53	11.425	< 0.001	1.285
Giraffe	10	5	8	17	9	6	2.625	NS	1.344
Hartebeest	14	4	4	12	4	4	-	NS	1
Impala	616	88	83	714	67	72	0.648	NS	1.146
Kudu	9	3	7	37	10	6	4.952	< 0.05	1.717
Puku	276	43	54	347	57	46	4.871	< 0.05	1.189
Reedbuck	7	4	5	17	6	5	0.400	NS	1.512
Roan	1	1	6	41	10	5	9.167	< 0.005	2.083
Warthog	50	18	26	70	31	23	5.244	< 0.025	1.245
Waterbuck	34	15	13	29	10	12	0.641	NS	1
Zebra	118	25	42	255	54	37	14.692	< 0.001	1.459

[a] buffalo herd sizes are very variable in the field and this may account for the difference in the number of animals seen by the two observers

Table 3 : Population estimates and statistics for Elephants in South Luangwa National Park and Lupande Game Management Area

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	781	71	178751	119.2	0	1711	1.40
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	1681	221	310541	68.1	536	2827	0.86
Stratum 4	852	111	34385	45.4	466	1239	0.76
Stratum 5	526	49	34152	73.8	138	915	0.47
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	394	37	36099	107.4	0	817	0.39
Nsefu	224	22	6893	102.7	0	455	0.99
Subtotals	**4459**	**511**	**600821**	**34.9**	**2905**	**6014**	**0.53**
Lupande GMA							
Upper Lupande	103	8	7106	226.6	0	337	0.14
West Lower Lupande	578	60	39605	74.4	148	1008	2.11
East Lower Lupande	222	12	38447	199.6	0	666	0.27
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	72	5	4383	226.4	0	234	0.07
Subtotals	**975**	**85**	**89541**	**63.1**	**359**	**1590**	**0.20**
Totals	**5434**	**596**	**690362**	**30.5**	**3775**	**7093**	**0.41**

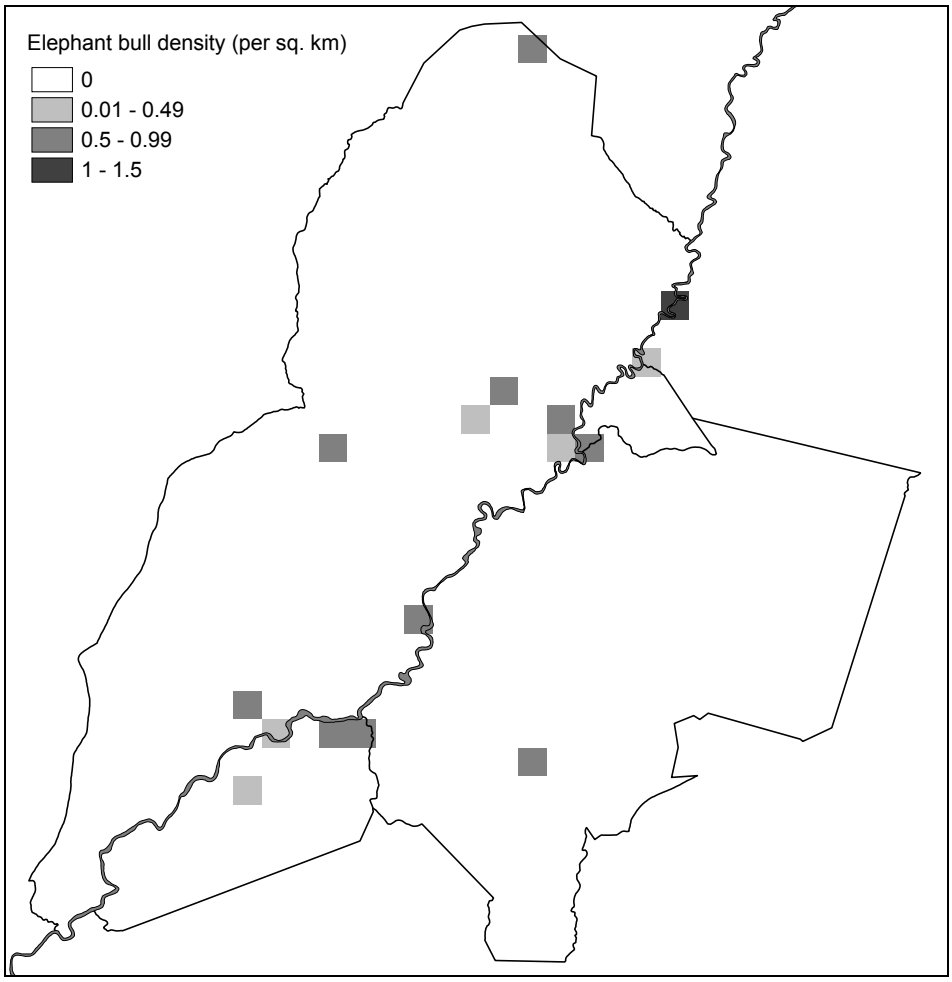


Map 2. Distribution of elephants in the central Luangwa Valley during August 2002

The Luangwa River, the boundary of the study area and the borders between South Luangwa NP and Lupande GMA are also shown. Elephant density is shown for each 5 km x 5 km map square in the study area.

Table 4 : Population estimates and statistics for Elephant bulls in South Luangwa National Park and Lupande Game Management Area

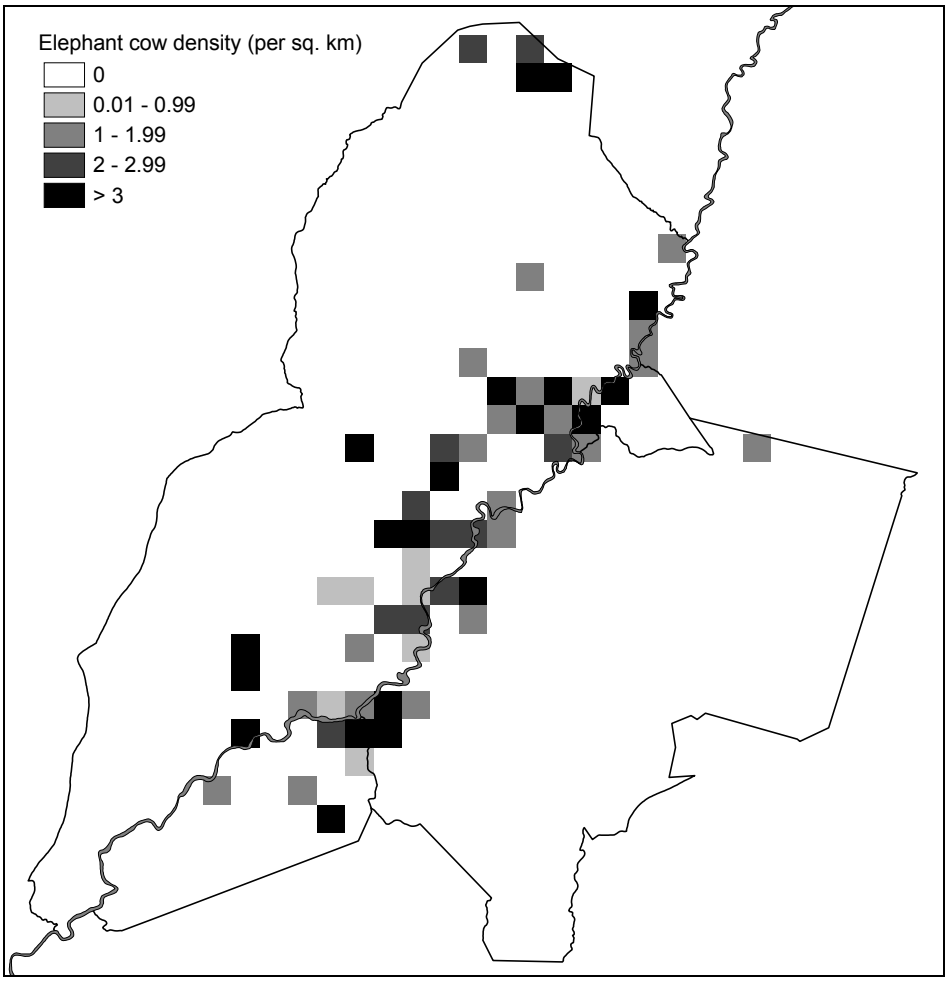
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	22	2	413	203.4	0	67	0.04
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	53	7	696	101.8	0	107	0.03
Stratum 4	31	4	257	108.9	0	64	0.03
Stratum 5	32	3	886	194.0	0	95	0.03
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	43	4	1055	169.9	0	115	0.04
Nsefu	10	1	132	312.3	0	42	0.05
Subtotals	**191**	**21**	**3438**	**61.4**	**74**	**308**	**0.02**
Lupande GMA							
Upper Lupande	26	2	711	286.7	0	100	0.03
West Lower Lupande	10	1	91	213.8	0	30	0.04
East Lower Lupande	37	2	1440	231.7	0	123	0.05
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**72**	**5**	**2241**	**140.1**	**0**	**174**	**0.01**
Totals	**263**	**26**	**5680**	**57.2**	**113**	**414**	**0.02**



Map 3. Distribution of elephant bulls in the central Luangwa Valley during August 2002

Table 5 : Population estimates and statistics for Elephants cows in South Luangwa National Park and Lupande Game Management Area

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	759	69	178338	122.5	0	1688	1.37
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	1628	214	309846	70.3	484	2773	0.83
Stratum 4	822	107	34128	46.9	436	1207	0.73
Stratum 5	494	46	33266	77.5	111	877	0.44
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	351	33	35044	118.7	0	768	0.35
Nsefu	214	21	6761	106.5	0	443	0.95
Subtotals	**4268**	**490**	**597382**	**36.3**	**2718**	**5819**	**0.51**
Lupande GMA							
Upper Lupande	77	6	6396	286.7	0	299	0.10
West Lower Lupande	568	59	39514	75.6	139	997	2.07
East Lower Lupande	185	10	37007	234.9	0	620	0.23
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	72	5	4383	226.4	0	234	0.07
Subtotals	**902**	**80**	**87300**	**67.3**	**295**	**1510**	**0.18**
Totals	**5171**	**570**	**684682**	**32.0**	**3518**	**6823**	**0.39**



Map 4. Distribution of elephant cows in the central Luangwa Valley during August 2002

Table 6 : Population estimates and statistics for Elephant carcasses (age category 3) in South Luangwa National Park and Lupande Game Management Area

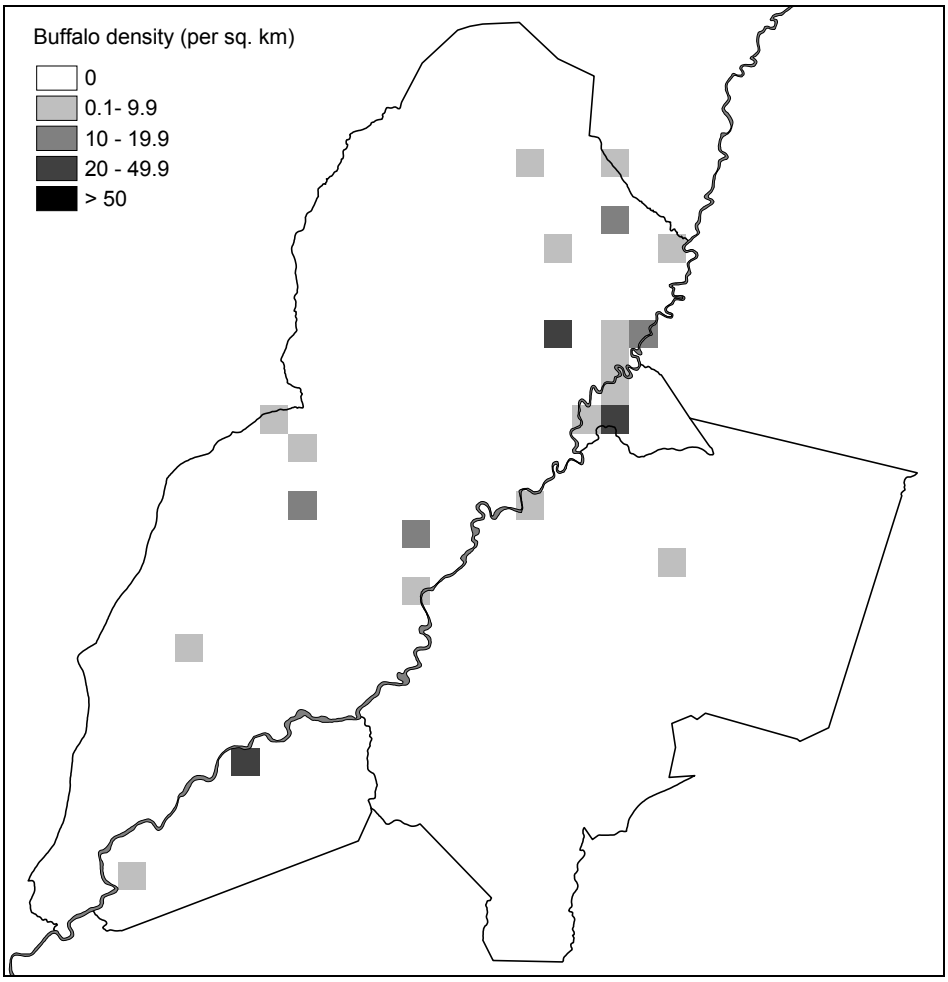
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	0	0	0	0.0	0	0	0.00
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	0	0	0	0.0	0	0	0.00
Stratum 4	0	0	0	0.0	0	0	0.00
Stratum 5	0	0	0	0.0	0	0	0.00
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	11	1	102	211.8	0	33	0.01
Nsefu	10	1	84	248.9	0	36	0.05
Subtotals	**21**	**2**	**186**	**142.6**	**0**	**51**	**0.002**
Lupande GMA							
Upper Lupande	13	1	160	272.4	0	48	0.02
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	37	2	1480	234.9	0	124	0.05
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**50**	**3**	**1641**	**180.7**	**0**	**140**	**0.01**
Totals	**71**	**5**	**1827**	**130.4**	**0**	**163**	**0.01**

Table 7 : Population estimates and statistics for unidentified carcasses in South Luangwa National Park and Lupande Game Management Area

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	11	1	105	205.1	0	34	0.02
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	8	1	50	190.9	0	22	0.00
Stratum 4	8	1	49	190.3	0	22	0.01
Stratum 5	0	0	0	0.0	0	0	0.00
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	0	0	0	0.0	0	0	0.00
Nsefu	10	1	82	246.0	0	35	0.05
Subtotals	**36**	**4**	**286**	**94.9**	**2**	**71**	**0.004**
Lupande GMA							
Upper Lupande	0	0	0	0.0	0	0	0.00
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**0**	**0**	**0**	**0.0**	**0**	**0**	**0.00**
Totals	**36**	**4**	**286**	**94.9**	**2**	**71**	**0.003**

Table 8 : Population estimates and statistics for Buffalo in South Luangwa National Park and Lupande Game Management Area

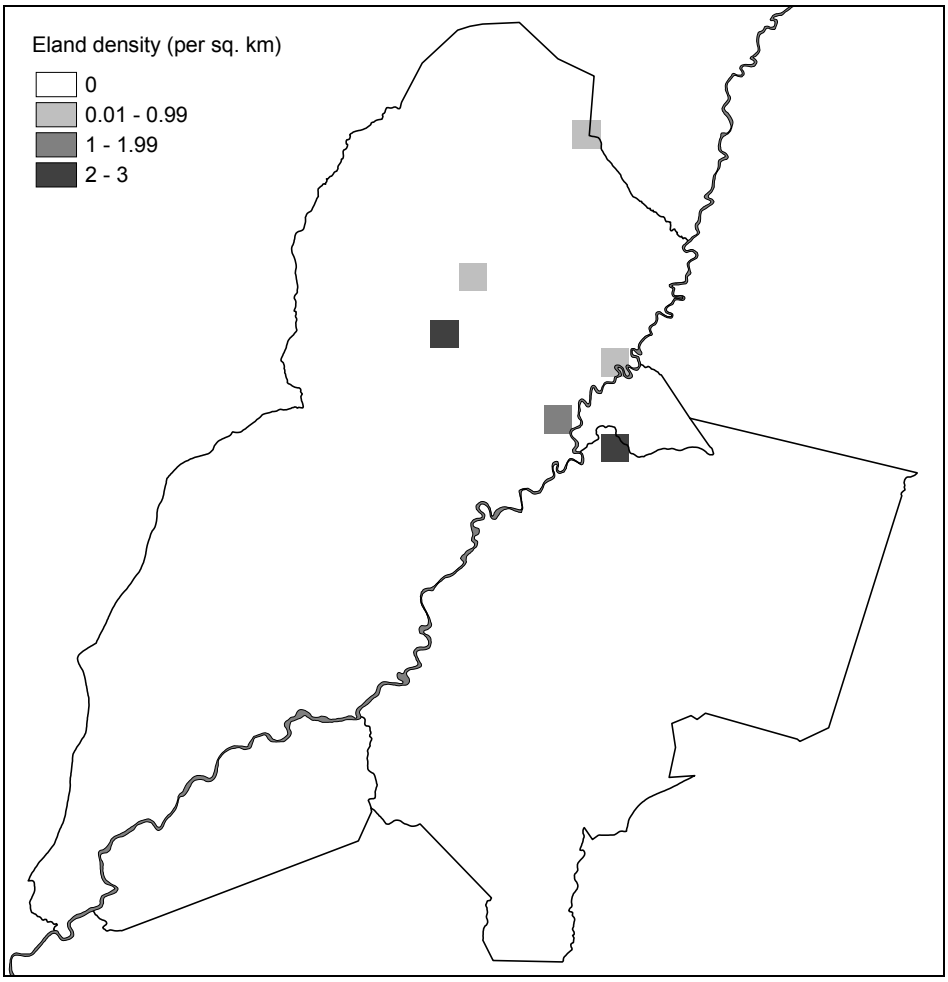
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	0	0	0	0.0	0	0	0.00
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	6041	794	15695965	134.8	0	14186	3.08
Stratum 4	584	76	128877	128.3	0	1332	0.52
Stratum 5	430	40	122473	171.1	0	1165	0.38
Lusiwasi	92	6	8406	211.7	0	286	0.08
Chilongozi	618	58	254993	182.2	0	1743	0.62
Nsefu	561	55	194818	218.3	0	1786	2.48
Subtotals	**8325**	**1029**	**16405532**	**99.6**	**30**	**16620**	**0.99**
Lupande GMA							
Upper Lupande	671	52	351629	245.3	0	2317	0.88
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	310	10	57788	199.3	0	928	0.17
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**981**	**62**	**409417**	**167.7**	**0**	**2626**	**0.20**
Totals	**9306**	**1091**	**16814949**	**90.1**	**920**	**17692**	**0.69**



Map 5. Distribution of buffalo in the central Luangwa Valley during August 2002

Table 9 : Population estimates and statistics for Eland in South Luangwa National Park and Lupande Game Management Area

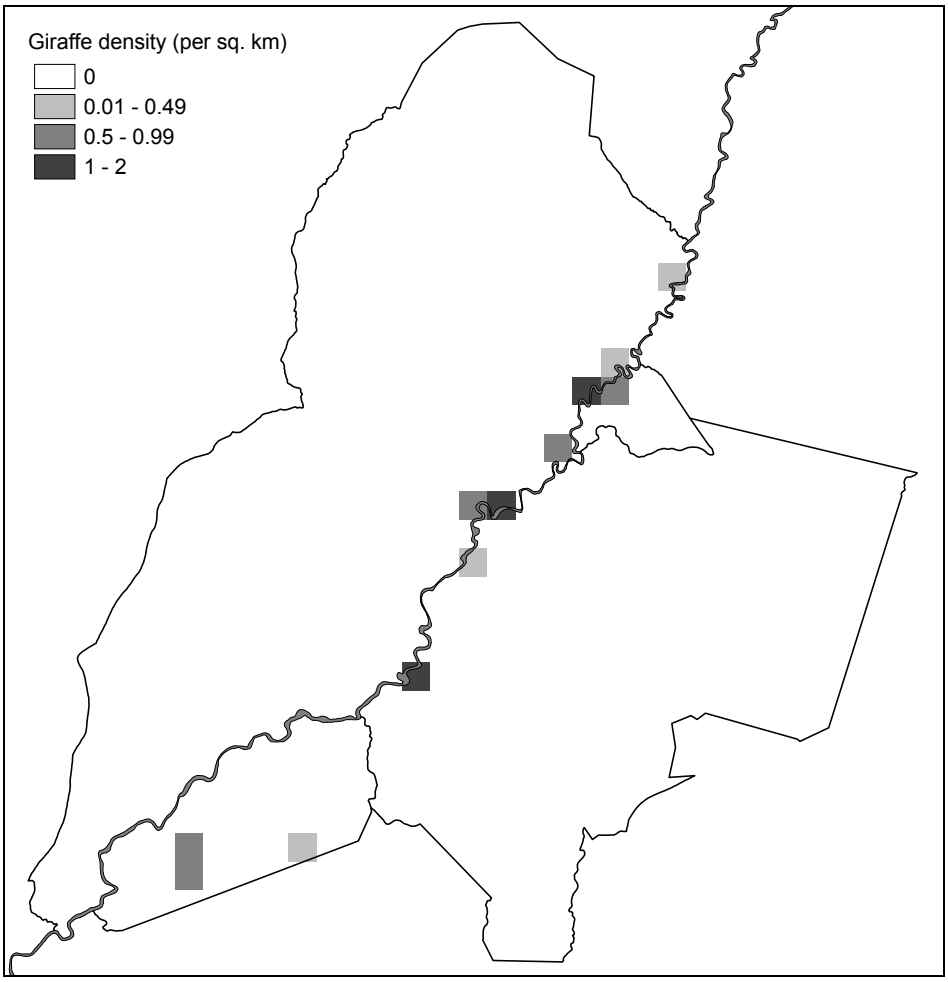
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	0	0	0	0.0	0	0	0.00
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	152	20	5997	104.6	0	311	0.08
Stratum 4	0	0	0	0.0	0	0	0.00
Stratum 5	0	0	0	0.0	0	0	0.00
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	0	0	0	0.0	0	0	0.00
Nsefu	0	0	0	0.0	0	0	0.00
Subtotals	**152**	**20**	**5997**	**104.6**	**0**	**311**	**0.02**
Lupande GMA							
Upper Lupande	52	4	2842	286.7	0	200	0.07
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**52**	**4**	**2842**	**286.7**	**0**	**200**	**0.01**
Totals	**204**	**24**	**8839**	**95.7**	**9**	**399**	**0.02**



Map 6. Distribution of eland in the central Luangwa Valley during August 2002

Table 10 : Population estimates and statistics for Thornicroft's Giraffe in South Luangwa National Park and Lupande Game Management Area

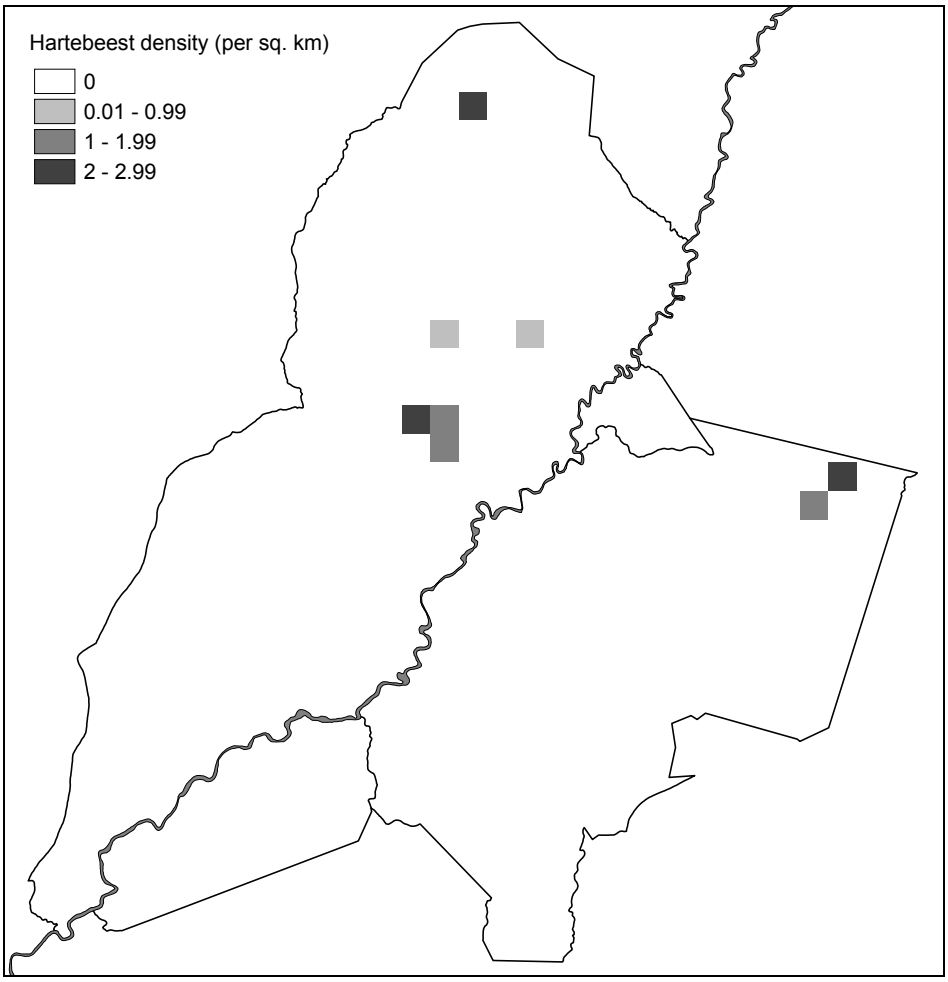
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	0	0	0	0.0	0	0	0.00
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	99	13	2553	105.0	0	203	0.05
Stratum 4	15	2	186	185.1	0	44	0.01
Stratum 5	0	0	0	0.0	0	0	0.00
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	43	4	393	103.7	0	87	0.04
Nsefu	31	3	536	209.9	0	95	0.14
Subtotals	**187**	**22**	**3667**	**65.4**	**65**	**310**	**0.02**
Lupande GMA							
Upper Lupande	0	0	0	0.0	0	0	0.00
West Lower Lupande	48	5	1471	172.1	0	131	0.18
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**48**	**5**	**1471**	**172.1**	**0**	**131**	**0.01**
Totals	**236**	**27**	**5139**	**61.0**	**92**	**379**	**0.02**



Map 7. Distribution of Thornicroft's giraffe in the central Luangwa Valley during August 2002

Table 11 : Population estimates and statistics for Lichtenstein's Hartebeest in South Luangwa National Park and Lupande Game Management Area

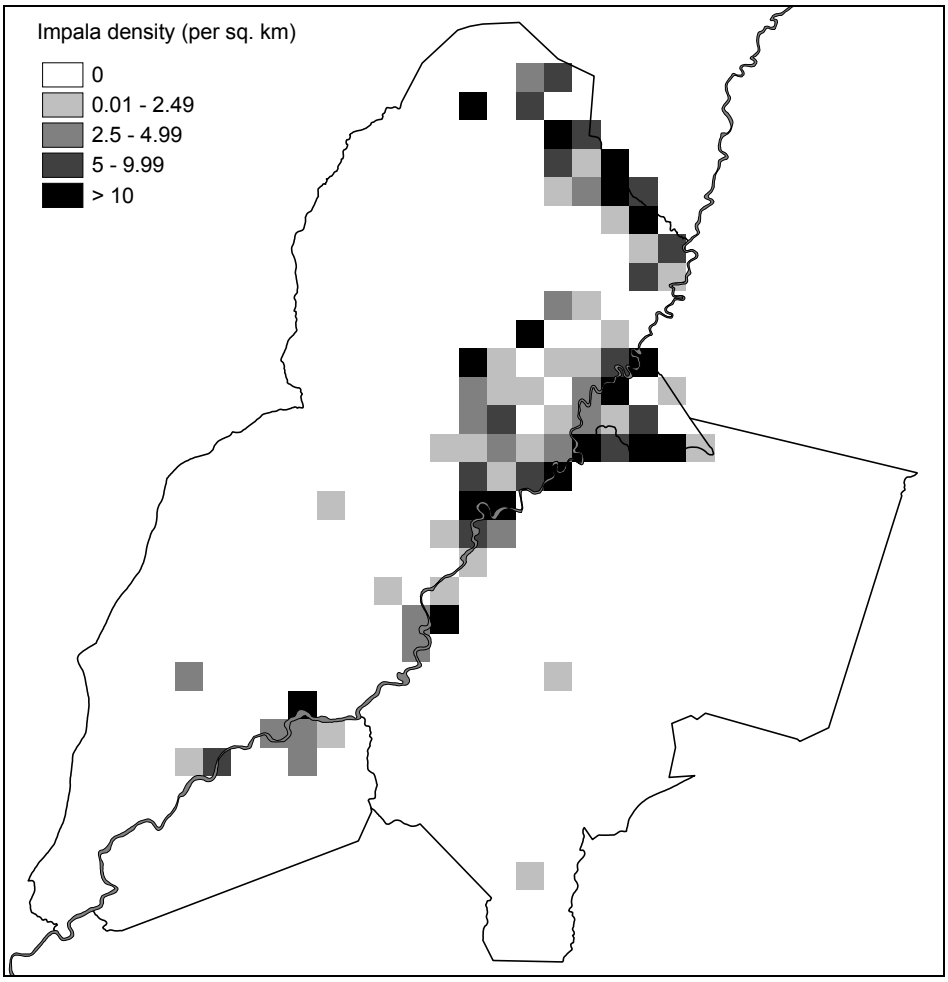
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	66	6	3765	204.7	0	201	0.12
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	76	10	1840	115.9	0	164	0.04
Stratum 4	31	4	760	187.2	0	88	0.03
Stratum 5	0	0	0	0.0	0	0	0.00
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	0	0	0	0.0	0	0	0.00
Nsefu	0	0	0	0.0	0	0	0.00
Subtotals	**173**	**20**	**6365**	**94.7**	**9**	**336**	**0.02**
Lupande GMA							
Upper Lupande	0	0	0	0.0	0	0	0.00
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	111	6	2855	153.8	0	281	0.38
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**111**	**6**	**2855**	**153.8**	**0**	**281**	**0.02**
Totals	**283**	**26**	**9220**	**70.7**	**83**	**484**	**0.02**



Map 8. Distribution of Lichtenstein's hartebeest in the central Luangwa Valley during August 2002

Table 12 : Population estimates and statistics for Impala in South Luangwa National Park and Lupande Game Management Area

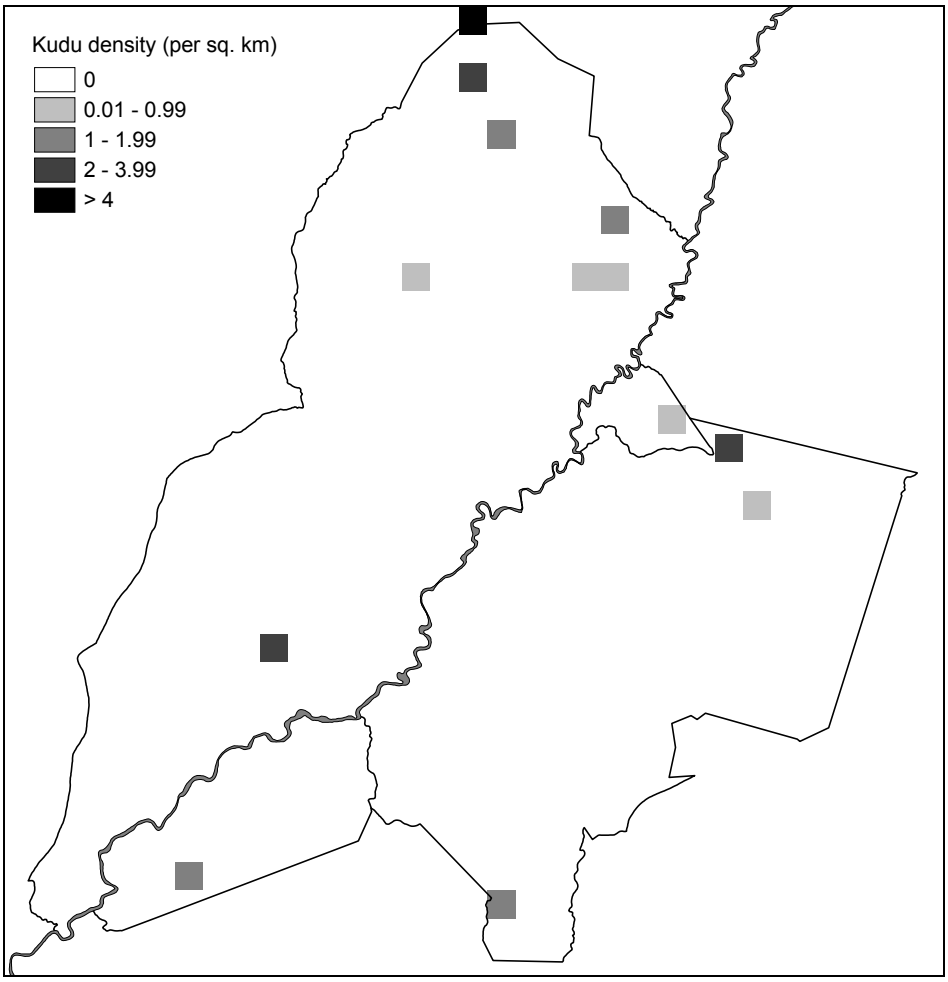
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	1342	122	348046	96.8	43	2640	2.41
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	5554	730	1024153	37.5	3473	7635	2.83
Stratum 4	868	113	106757	78.5	186	1549	0.77
Stratum 5	333	31	33495	115.5	0	718	0.30
Lusiwasi	168	11	18255	170.2	0	455	0.14
Chilongozi	788	74	389484	176.5	0	2178	0.79
Nsefu	1214	119	230297	109.7	0	2546	5.37
Subtotals	**10267**	**1200**	**2150487**	**28.6**	**7331**	**13203**	**1.22**
Lupande GMA							
Upper Lupande	813	63	705116	286.7	0	3144	1.06
West Lower Lupande	539	56	112626	134.5	0	1264	1.97
East Lower Lupande	167	9	14960	166.0	0	443	0.20
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	29	2	871	252.3	0	101	0.03
Subtotals	**1548**	**130**	**833572**	**151.7**	**0**	**3895**	**0.31**
Totals	**11814**	**1330**	**2984060**	**29.5**	**8330**	**15299**	**0.88**



Map 9. Distribution of impala in the central Luangwa Valley during August 2002

Table 13 : Population estimates and statistics for Kudu in South Luangwa National Park and Lupande Game Management Area

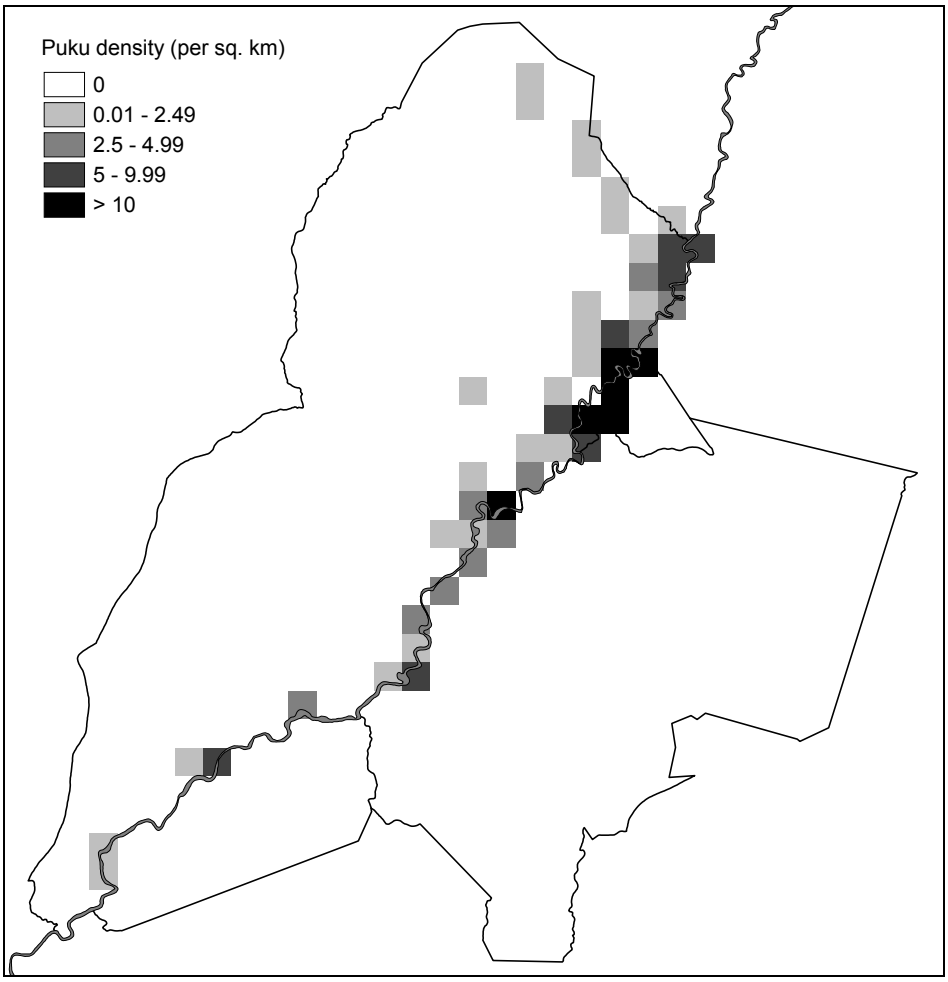
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	110	10	10459	204.7	0	335	0.20
Nosbara	76	5	4956	207.5	0	232	0.06
Lubi	91	12	2304	108.1	0	190	0.05
Stratum 4	0	0	0	0.0	0	0	0.00
Stratum 5	64	6	3603	195.6	0	191	0.06
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	21	2	401	209.6	0	66	0.02
Nsefu	10	1	82	246.0	0	35	0.05
Subtotals	**373**	**36**	**21804**	**80.4**	**73**	**673**	**0.04**
Lupande GMA							
Upper Lupande	103	8	8107	242.1	0	353	0.14
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	29	2	648	217.6	0	91	0.03
Subtotals	**132**	**10**	**8755**	**197.0**	**0**	**392**	**0.03**
Totals	**505**	**46**	**30559**	**70.6**	**148**	**861**	**0.04**



Map 10. Distribution of kudu in the central Luangwa Valley during August 2002

Table 14 : Population estimates and statistics for Puku in South Luangwa National Park and Lupande Game Management Area

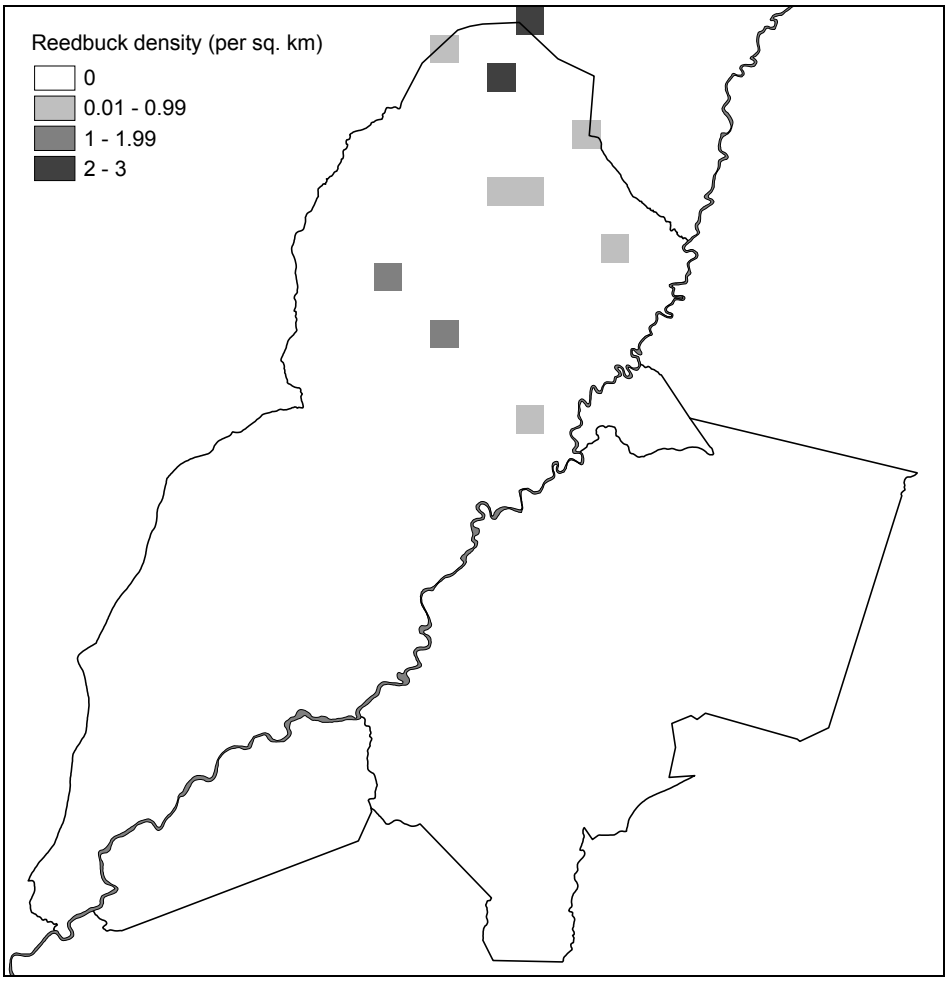
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	88	8	6612	203.4	0	267	0.16
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	2047	269	152666	39.3	1243	2850	1.04
Stratum 4	323	42	14506	77.9	71	574	0.29
Stratum 5	215	20	16832	126.9	0	487	0.19
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	75	7	1777	126.0	0	168	0.07
Nsefu	2020	198	804954	123.3	0	4511	8.94
Subtotals	**4767**	**544**	**997346**	**51.3**	**2323**	**7211**	**0.56**
Lupande GMA							
Upper Lupande	310	24	102330	286.7	0	1198	0.41
West Lower Lupande	472	49	72581	123.4	0	1054	1.72
East Lower Lupande	111	6	13322	234.9	0	372	0.14
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**893**	**79**	**188233**	**107.0**	**0**	**1848**	**0.18**
Totals	**5659**	**623**	**1185579**	**44.4**	**3149**	**8170**	**0.42**



Map 11. Distribution of puku in the central Luangwa Valley during August 2002

Table 15 : Population estimates and statistics for Reedbuck in South Luangwa National Park and Lupande Game Management Area

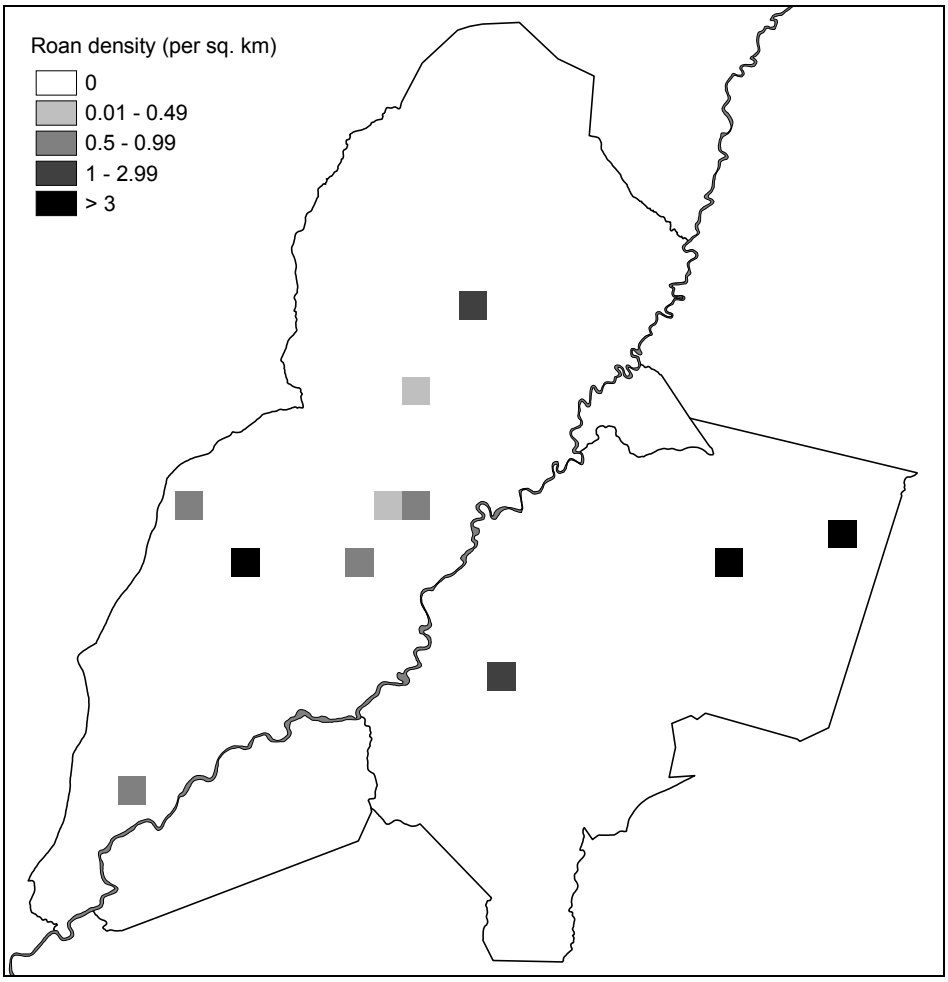
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	88	8	1780	105.5	0	181	0.16
Nosbara	30	2	914	222.8	0	98	0.03
Lubi	107	14	2167	89.8	11	202	0.05
Stratum 4	0	0	0	0.0	0	0	0.00
Stratum 5	0	0	0	0.0	0	0	0.00
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	0	0	0	0.0	0	0	0.00
Nsefu	0	0	0	0.0	0	0	0.00
Subtotals	**225**	**24**	**4860**	**62.6**	**84**	**365**	**0.03**
Lupande GMA							
Upper Lupande	0	0	0	0.0	0	0	0.00
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**0**	**0**	**0**	**0.0**	**0**	**0**	**0.00**
Totals	**225**	**24**	**4860**	**62.6**	**84**	**365**	**0.02**



Map 12. Distribution of reedbuck in the central Luangwa Valley during August 2002

Table 16 : Population estimates and statistics for Roan Antelope in South Luangwa National Park and Lupande Game Management Area

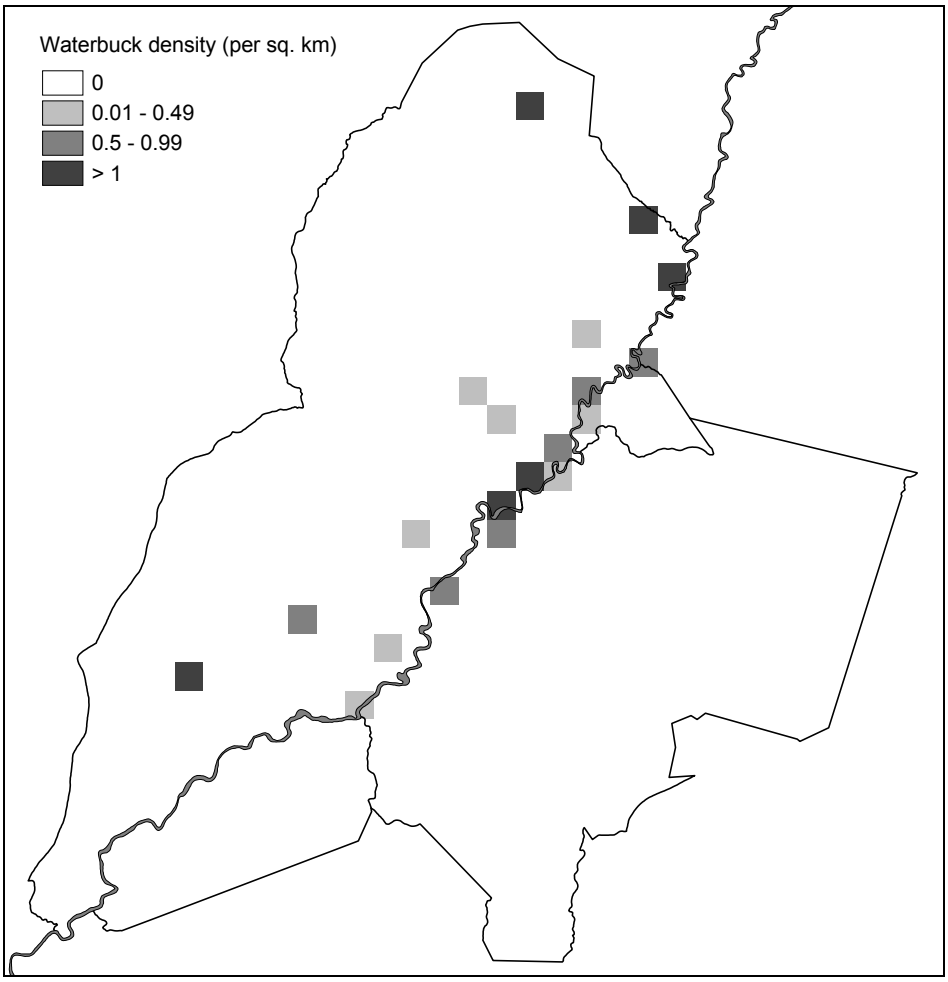
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	0	0	0	0.0	0	0	0.00
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	76	10	3881	168.3	0	204	0.04
Stratum 4	38	5	374	105.1	0	79	0.03
Stratum 5	86	8	5239	176.9	0	238	0.08
Lusiwasi	15	1	219	205.2	0	47	0.01
Chilongozi	0	0	0	0.0	0	0	0.00
Nsefu	0	0	0	0.0	0	0	0.00
Subtotals	**216**	**24**	**9713**	**92.1**	**17**	**414**	**0.03**
Lupande GMA							
Upper Lupande	0	0	0	0.0	0	0	0.00
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	111	6	8906	271.6	0	411	0.38
East Lupande	248	8	36984	199.3	0	742	0.14
Lupande Hills	57	4	2591	217.6	0	182	0.06
Subtotals	**416**	**18**	**48482**	**125.2**	**0**	**937**	**0.08**
Totals	**632**	**42**	**58195**	**84.1**	**101**	**1163**	**0.05**



Map 13. Distribution of roan antelope in the central Luangwa Valley during August 2002

Table 17 : Population estimates and statistics for Waterbuck in South Luangwa National Park and Lupande Game Management Area

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	88	8	3938	157.0	0	226	0.16
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	312	41	8959	62.4	117	507	0.16
Stratum 4	15	2	94	131.6	0	36	0.01
Stratum 5	32	3	914	197.1	0	96	0.03
Lusiwasi	61	4	3604	207.9	0	188	0.05
Chilongozi	0	0	0	0.0	0	0	0.00
Nsefu	10	1	82	246.0	0	35	0.05
Subtotals	**519**	**59**	**17591**	**51.2**	**253**	**784**	**0.06**
Lupande GMA							
Upper Lupande	0	0	0	0.0	0	0	0.00
West Lower Lupande	19	2	143	134.0	0	45	0.07
East Lower Lupande	37	2	1480	234.9	0	124	0.05
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**56**	**4**	**1623**	**159.4**	**0**	**146**	**0.01**
Totals	**575**	**63**	**19214**	**48.1**	**298**	**852**	**0.04**



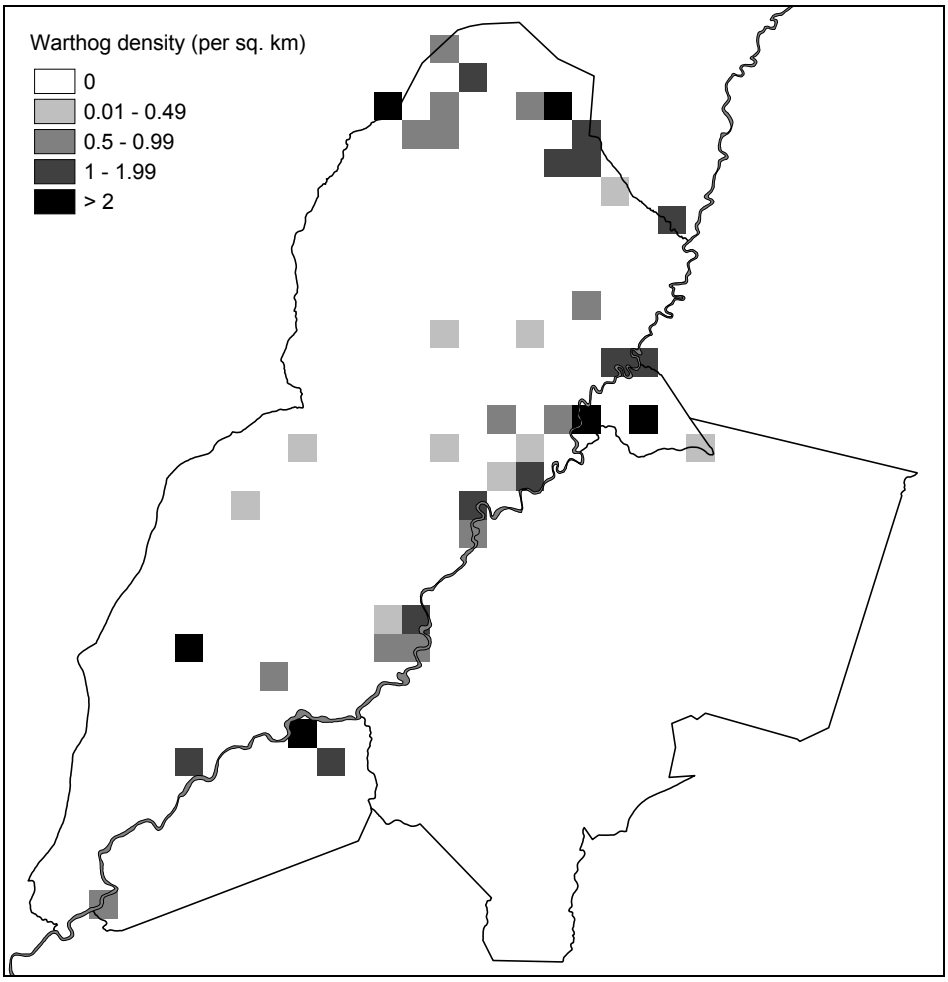
Map 14. Distribution of waterbuck in the central Luangwa Valley during August 2002

Table 18 : Population estimates and statistics for Cookson's Wildebeest in South Luangwa National Park and Lupande Game Management Area

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	11	1	115	215.0	0	35	0.02
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	0	0	0	0.0	0	0	0.00
Stratum 4	0	0	0	0.0	0	0	0.00
Stratum 5	0	0	0	0.0	0	0	0.00
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	0	0	0	0.0	0	0	0.00
Nsefu	0	0	0	0.0	0	0	0.00
Subtotals	**11**	**1**	**115**	**215.0**	**0**	**35**	**0.001**
Lupande GMA							
Upper Lupande	516	40	284249	286.7	0	1996	0.68
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**516**	**40**	**284249**	**286.7**	**0**	**1996**	**0.10**
Totals	**527**	**41**	**284365**	**280.8**	**0**	**2008**	**0.04**

Table 19 : Population estimates and statistics for Warthog in South Luangwa National Park and Lupande Game Management Area

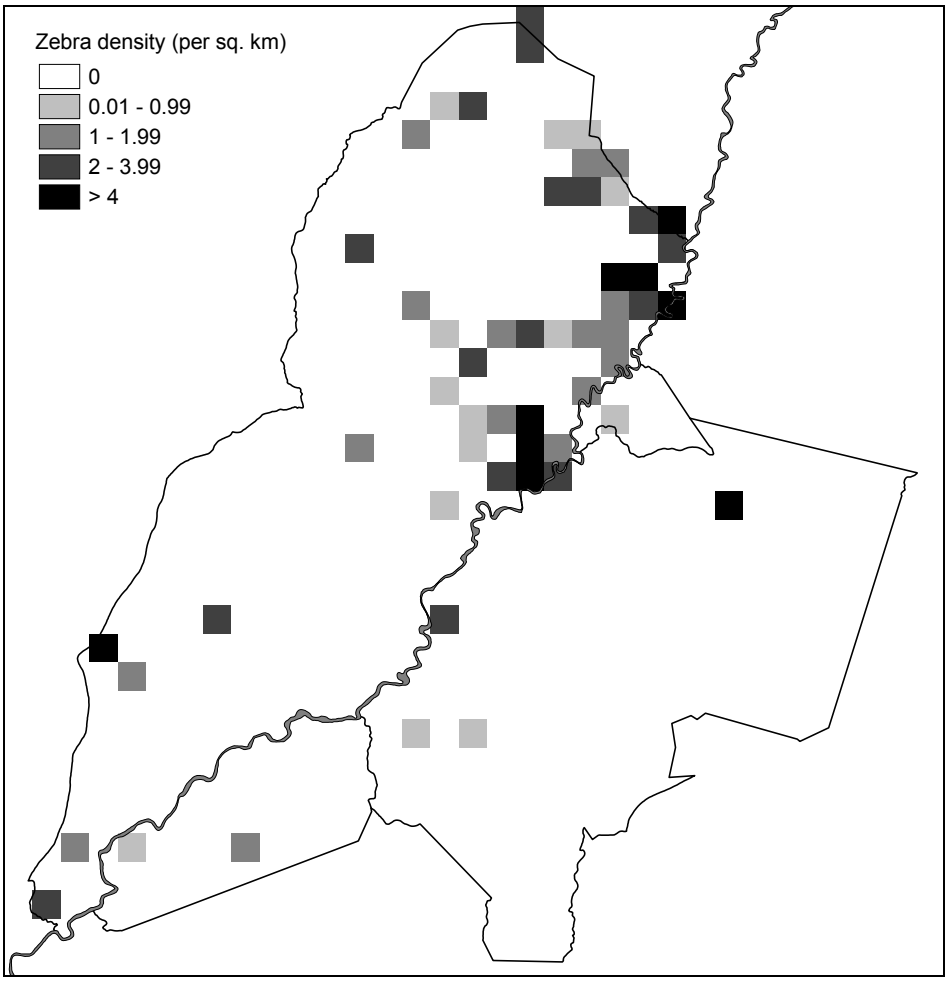
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	275	25	13433	92.8	20	530	0.49
Nosbara	30	2	793	207.5	0	93	0.03
Lubi	304	40	8096	60.8	119	489	0.16
Stratum 4	154	20	4241	88.5	18	289	0.14
Stratum 5	64	6	1214	113.6	0	138	0.06
Lusiwasi	61	4	1769	145.7	0	150	0.05
Chilongozi	75	7	3037	164.7	0	197	0.07
Nsefu	143	14	4003	123.0	0	318	0.63
Subtotals	**1106**	**118**	**36586**	**34.7**	**722**	**1490**	**0.13**
Lupande GMA							
Upper Lupande	13	1	178	286.7	0	50	0.02
West Lower Lupande	10	1	89	211.9	0	30	0.04
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**23**	**2**	**267**	**167.2**	**0**	**60**	**0.005**
Totals	**1129**	**120**	**36853**	**34.1**	**744**	**1514**	**0.08**



Map 15. Distribution of warthog in the central Luangwa Valley during August 2002

Table 20 : Population estimates and statistics for Zebra in South Luangwa National Park and Lupande Game Management Area

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	231	21	14429	114.5	0	495	0.42
Nosbara	136	9	7363	140.5	0	327	0.11
Lubi	2130	280	138822	36.0	1364	2896	1.09
Stratum 4	69	9	994	95.2	3	135	0.06
Stratum 5	54	5	2539	197.1	0	160	0.05
Lusiwasi	230	15	12758	104.3	0	469	0.19
Chilongozi	96	9	2889	125.0	0	216	0.10
Nsefu	10	1	84	248.9	0	36	0.05
Subtotals	**2956**	**349**	**179877**	**29.0**	**2099**	**3812**	**0.35**
Lupande GMA							
Upper Lupande	232	18	50613	268.8	0	857	0.30
West Lower Lupande	48	5	1071	146.8	0	119	0.18
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	14	1	175	226.4	0	47	0.01
Subtotals	**295**	**24**	**51859**	**214.5**	**0**	**927**	**0.06**
Totals	**3250**	**373**	**231737**	**30.0**	**2275**	**4226**	**0.24**



Map 16. Distribution of zebra in the central Luangwa Valley during August 2002

Table 21 : Population estimates and statistics for Ground Hornbill in South Luangwa National Park and Lupande Game Management Area

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	44	4	1737	208.5	0	136	0.08
Nosbara	45	3	1989	219.1	0	145	0.04
Lubi	114	15	2730	94.1	7	222	0.06
Stratum 4	0	0	0	0.0	0	0	0.00
Stratum 5	43	4	959	151.4	0	108	0.04
Lusiwasi	46	3	2098	211.5	0	143	0.04
Chilongozi	21	2	410	211.8	0	66	0.02
Nsefu	10	1	84	248.9	0	36	0.05
Subtotals	**324**	**32**	**10007**	**61.5**	**125**	**523**	**0.04**
Lupande GMA							
Upper Lupande	0	0	0	0.0	0	0	0.00
West Lower Lupande	10	1	76	195.0	0	28	0.04
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	124	4	7219	176.1	0	342	0.07
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**134**	**5**	**7294**	**164.3**	**0**	**353**	**0.03**
Totals	**457**	**37**	**17301**	**59.2**	**187**	**728**	**0.03**

Table 22 : Population estimates and statistics for Sheep and Goats in South Luangwa National Park and Lupande Game Management Area

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	0	0	0	0.0	0	0	0.00
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	0	0	0	0.0	0	0	0.00
Stratum 4	0	0	0	0.0	0	0	0.00
Stratum 5	0	0	0	0.0	0	0	0.00
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	0	0	0	0.0	0	0	0.00
Nsefu	0	0	0	0.0	0	0	0.00
Subtotals	**0**	**0**	**0**	**0.0**	**0**	**0**	**0.00**
Lupande GMA							
Upper Lupande	0	0	0	0.0	0	0	0.00
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	278	15	82981	234.5	0	929	0.34
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	682	22	73598	102.3	0	1380	0.38
Lupande Hills	215	15	48988	252.3	0	756	0.21
Subtotals	**1175**	**52**	**205567**	**81.1**	**222**	**2127**	**0.24**
Totals	**1175**	**52**	**205567**	**81.1**	**222**	**2127**	**0.09**

Table 23 : Population estimates and statistics for Poachers' Camps in South Luangwa National Park and Lupande Game Management Area

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km^{-2})
South Luangwa NP							
Chifungwe	0	0	0	0.0	0	0	0.00
Nosbara	0	0	0	0.0	0	0	0.00
Lubi	23	3	228	136.0	0	54	0.01
Stratum 4	15	2	88	127.3	0	35	0.01
Stratum 5	21	2	173	128.6	0	49	0.02
Lusiwasi	0	0	0	0.0	0	0	0.00
Chilongozi	0	0	0	0.0	0	0	0.00
Nsefu	0	0	0	0.0	0	0	0.00
Subtotals	**60**	**7**	**489**	**74.1**	**15**	**104**	**0.01**
Lupande GMA							
Upper Lupande	0	0	0	0.0	0	0	0.00
West Lower Lupande	0	0	0	0.0	0	0	0.00
East Lower Lupande	0	0	0	0.0	0	0	0.00
Machinje	0	0	0	0.0	0	0	0.00
East Lupande	0	0	0	0.0	0	0	0.00
Lupande Hills	0	0	0	0.0	0	0	0.00
Subtotals	**0**	**0**	**0**	**0.0**	**0**	**0**	**0.00**
Totals	**60**	**7**	**489**	**74.1**	**15**	**104**	**0.004**

Appendix 1. Calibration to determine strip width

Strip width (in meters) for one observer = 10 x (Difference between outer and inner + 1).

Combined strip width (in meters) = 10 x ($Difference_{left}$ + $Difference_{right}$ + 2).

Combined strip width at 300 feet agl [1] = Combined strip width x 300 / (Height agl)

[1] agl: above ground level

Run no.	Left observer: Paul Zyambo			Right observer: Wilfred Moonga			Combined strip width (in meters) at actual height	Height agl (feet)	Combined strip width (in meters) at 300 feet agl
	Outer Marker	Inner Marker	Strip Width (m)	Outer Marker	Inner Marker	Strip Width (m)			
1	30	13	180	29	16	140	320	300	320
2	26	10	170	30	17	140	310	300	310
3	30	14	170	28	14	150	320	300	320
4	29	12	180	28	14	150	330	300	330
5	28	12	170	27	14	140	310	300	310
6	26	10	170	32	17	160	330	300	330
7	27	11	170	29	15	150	320	300	320
8	27	11	170	32	16	170	340	310	329
9	30	14	170	28	14	150	320	310	310
10	23	9	150	28	14	150	300	280	321
11	27	11	170	34	18	170	340	340	300
12	28	12	170	27	13	150	320	300	320
13	30	13	180	29	15	150	330	300	330
14	27	11	170	30	16	150	320	330	291
15	28	12	170	30	16	150	320	340	282
16	26	10	170	28	14	150	320	300	320
17	>35	16		25	12	140		330	
18	27	11	170	28	14	150	320	300	320
19	29	13	170	29	15	150	320	300	320
20	20	9	120	27	13	150	270	250	324
21	30	18	130	29	13	170	300	300	300
22	28	13	160	28	13	160	320	300	320
23	>35	18		32	14	190		350	
24	27	10	180	31	18	140	320	340	282
25	28	12	170	20	9	120	290	250	348
26	29	11	190	29	16	140	330	300	330
27	35	16	200	23	10	140	340	300	340
28	28	10	190	35	16	200	390	330	355
29	>35	18		27	12	160		340	
30	27	10	180	29	15	150	330	300	330
31	32	16	170	25	11	150	320	310	310
32	26	10	170	28	15	140	310	290	321

Run no.	Left observer: Paul Zyambo			Right observer: Wilfred Moonga			Combined strip width (in meters) at actual height	Height agl (feet)	Combined strip width (in meters) at 300 feet agl
	Outer Marker	Inner Marker	Strip Width (m)	Outer Marker	Inner Marker	Strip Width (m)			
33	25	10	160	22	11	120	280	250	336
34	26	10	170	29	15	150	320	300	320
35	31	13	190	23	10	140	330	290	341
36	28	13	160	28	14	150	310	310	300
37	>35	17		29	14	160		350	
38	24	10	150	24	10	150	300	250	360
39	27	13	150	19	9	110	260	260	300
40	29	12	180	26	14	130	310	300	310
41	25	11	150	24	12	130	280	260	323
42	30	14	170	24	12	130	300	300	300
43	27	10	180	31	18	140	320	340	282
44	31	13	190	32	15	180	370	300	370
45	29	12	180	29	19	110	290	290	300
46	31	14	180	27	13	150	330	320	309
47	26	11	160	24	14	110	270	290	279
Mean combined strip width (in meters) at 300 feet agl =									**318**

Appendix 2. Aerial survey flight summary

Date	Time	Flight time (hours:minutes)	Duty
10-Aug-02	pm	2:30 approx.	Positioning, Harare to Mfuwe
11-Aug-02	pm	0:07	Calibration
11-Aug-02	pm	0:07	Calibration
11-Aug-02	pm	0:37	Calibration
11-Aug-02	pm	0:09	Calibration
12-Aug-02	pm	0:33	Calibration
12-Aug-02	am	0:50	Calibration
12-Aug-02	am	0:56	Calibration
12-Aug-02	pm	1:38	Stratum East Lupande
13-Aug-02	am	3:44	Strata Chifungwe & Nosbara
13-Aug-02	pm	1:33	Stratum East Lower Lupande
14-Aug-02	am	4:22	Stratum Lubi
14-Aug-02	pm	2:11	Stratum Lubi continued
15-Aug-02	am	3:18	Strata 4 & Lower West Lupande
15-Aug-02	pm	1:28	Stratum 4 continued
17-Aug-02	am	3:21	Stratum 5
17-Aug-02	pm	2:17	Strata Machinje & Upper Lupande
18-Aug-02	am	4:20	Strata Lupande Hills & Chilongozi
18-Aug-02	pm	1:14	Stratum Nsefu
19-Aug-02	am	3:04	Stratum Lusiwasi
19-Aug-02	pm	2:30 approx.	Positioning, Mfuwe to Harare

Appendix 3. Transect start and end points.

1 Chifungwe

Number of transects : 12
Transect Bearing : 0.00 Degrees
Transect Spacing : 3.50 km

Transect # : 1
Start Lat : S 12 : 30.472 Start Lon : E 31 : 54.067
Finish Lat : S 12 : 23.965 Finish Lon : E 31 : 54.067
Length : 12.05 km

Transect # : 2
Start Lat : S 12 : 22.954 Start Lon : E 31 : 52.133
Finish Lat : S 12 : 30.472 Finish Lon : E 31 : 52.133
Length : 13.92 km

Transect # : 3
Start Lat : S 12 : 30.472 Start Lon : E 31 : 50.199
Finish Lat : S 12 : 21.162 Finish Lon : E 31 : 50.199
Length : 17.24 km

Transect # : 4
Start Lat : S 12 : 19.693 Start Lon : E 31 : 48.266
Finish Lat : S 12 : 30.472 Finish Lon : E 31 : 48.266
Length : 19.96 km

Transect # : 5
Start Lat : S 12 : 30.472 Start Lon : E 31 : 46.332
Finish Lat : S 12 : 19.762 Finish Lon : E 31 : 46.332
Length : 19.83 km

Transect # : 6
Start Lat : S 12 : 19.919 Start Lon : E 31 : 44.399
Finish Lat : S 12 : 30.472 Finish Lon : E 31 : 44.399
Length : 19.54 km

Transect # : 7
Start Lat : S 12 : 30.472 Start Lon : E 31 : 42.465
Finish Lat : S 12 : 20.529 Finish Lon : E 31 : 42.465
Length : 18.41 km

Transect # : 8
Start Lat : S 12 : 22.258 Start Lon : E 31 : 40.532
Finish Lat : S 12 : 30.472 Finish Lon : E 31 : 40.532
Length : 15.21 km

Transect # : 9
Start Lat : S 12 : 30.472 Start Lon : E 31 : 38.598
Finish Lat : S 12 : 24.508 Finish Lon : E 31 : 38.598
Length : 11.04 km

Transect # : 10
Start Lat : S 12 : 27.736 Start Lon : E 31 : 36.664
Finish Lat : S 12 : 30.472 Finish Lon : E 31 : 36.664
Length : 5.07 km

Transect # : 11
Start Lat : S 12 : 30.472 Start Lon : E 31 : 34.731
Finish Lat : S 12 : 28.901 Finish Lon : E 31 : 34.731
Length : 2.91 km

Transect # : 12
Start Lat : S 12 : 29.923 Start Lon : E 31 : 32.797
Finish Lat : S 12 : 30.472 Finish Lon : E 31 : 32.797
Length : 1.02 km

2 Nosbara

Number of transects : 11
Transect Bearing : 90.00 Degrees
Transect Spacing : 5.00 km

Transect # : 1
Start Lat : S 12 : 31.262 Start Lon : E 31 : 31.856
Finish Lat : S 12 : 31.262 Finish Lon : E 31 : 51.281
Length : 35.12 km

Transect # : 2
Start Lat : S 12 : 33.962 Start Lon : E 31 : 47.202
Finish Lat : S 12 : 33.962 Finish Lon : E 31 : 30.478
Length : 30.24 km

Transect # : 3
Start Lat : S 12 : 36.662 Start Lon : E 31 : 28.716
Finish Lat : S 12 : 36.662 Finish Lon : E 31 : 44.035
Length : 27.70 km

Transect # : 4
Start Lat : S 12 : 39.362 Start Lon : E 31 : 40.253
Finish Lat : S 12 : 39.362 Finish Lon : E 31 : 27.368
Length : 23.30 km

Transect # : 5
Start Lat : S 12 : 42.062 Start Lon : E 31 : 26.648
Finish Lat : S 12 : 42.062 Finish Lon : E 31 : 38.390
Length : 21.23 km

Transect # : 6
Start Lat : S 12 : 44.762 Start Lon : E 31 : 38.031
Finish Lat : S 12 : 44.762 Finish Lon : E 31 : 26.925

Length : 20.08 km

Transect # : 7
Start Lat : S 12 : 47.462 Start Lon : E 31 : 26.702
Finish Lat : S 12 : 47.462 Finish Lon : E 31 : 38.096
Length : 20.60 km

Transect # : 8
Start Lat : S 12 : 50.162 Start Lon : E 31 : 38.837
Finish Lat : S 12 : 50.162 Finish Lon : E 31 : 25.863
Length : 23.46 km

Transect # : 9
Start Lat : S 12 : 52.862 Start Lon : E 31 : 25.619
Finish Lat : S 12 : 52.862 Finish Lon : E 31 : 38.403
Length : 23.12 km

Transect # : 10
Start Lat : S 12 : 55.562 Start Lon : E 31 : 37.969
Finish Lat : S 12 : 55.562 Finish Lon : E 31 : 27.237
Length : 19.41 km

Transect # : 11
Start Lat : S 12 : 58.262 Start Lon : E 31 : 33.858
Finish Lat : S 12 : 58.262 Finish Lon : E 31 : 37.727
Length : 7.00 km

3 Lubi

Number of transects : 27
Transect Bearing : 90.00 Degrees
Transect Spacing : 2.50 km

Transect # : 1
Start Lat : S 12 : 31.582 Start Lon : E 31 : 56.511
Finish Lat : S 12 : 31.582 Finish Lon : E 31 : 51.046
Length : 9.88 km

Transect # : 2
Start Lat : S 12 : 32.932 Start Lon : E 31 : 47.202
Finish Lat : S 12 : 32.932 Finish Lon : E 31 : 57.312
Length : 18.28 km

Transect # : 3
Start Lat : S 12 : 34.282 Start Lon : E 31 : 58.403
Finish Lat : S 12 : 34.282 Finish Lon : E 31 : 47.202
Length : 20.25 km

Transect # : 4
Start Lat : S 12 : 35.632 Start Lon : E 31 : 45.453
Finish Lat : S 12 : 35.632 Finish Lon : E 31 : 59.201
Length : 24.86 km

Transect # : 5
Start Lat : S 12 : 36.982 Start Lon : E 32 : 0.593
Finish Lat : S 12 : 36.982 Finish Lon : E 31 : 43.713
Length : 30.52 km

Transect # : 6
Start Lat : S 12 : 38.332 Start Lon : E 31 : 40.835
Finish Lat : S 12 : 38.332 Finish Lon : E 32 : 2.649
Length : 39.45 km

Transect # : 7
Start Lat : S 12 : 39.682 Start Lon : E 32 : 3.813
Finish Lat : S 12 : 39.682 Finish Lon : E 31 : 40.101
Length : 42.88 km

Transect # : 8
Start Lat : S 12 : 41.032 Start Lon : E 31 : 39.413
Finish Lat : S 12 : 41.032 Finish Lon : E 32 : 4.537
Length : 45.43 km

Transect # : 9
Start Lat : S 12 : 42.382 Start Lon : E 32 : 5.171
Finish Lat : S 12 : 42.382 Finish Lon : E 31 : 38.339
Length : 48.52 km

Transect # : 10
Start Lat : S 12 : 43.732 Start Lon : E 31 : 37.829
Finish Lat : S 12 : 43.732 Finish Lon : E 32 : 4.836
Length : 48.84 km

Transect # : 11
Start Lat : S 12 : 45.082 Start Lon : E 32 : 3.501
Finish Lat : S 12 : 45.082 Finish Lon : E 31 : 37.964
Length : 46.18 km

Transect # : 12
Start Lat : S 12 : 46.432 Start Lon : E 31 : 38.051
Finish Lat : S 12 : 46.432 Finish Lon : E 32 : 3.335
Length : 45.72 km

Transect # : 13
Start Lat : S 12 : 47.782 Start Lon : E 32 : 1.862
Finish Lat : S 12 : 47.782 Finish Lon : E 31 : 38.133
Length : 42.91 km

Transect # : 14
Start Lat : S 12 : 49.132 Start Lon : E 31 : 39.003
Finish Lat : S 12 : 49.132 Finish Lon : E 32 : 1.225
Length : 40.18 km

Transect # : 15
Start Lat : S 12 : 50.482 Start Lon : E 32 : 0.120
Finish Lat : S 12 : 50.482 Finish Lon : E 31 : 38.786
Length : 38.58 km

Transect # : 16

Start Lat : S 12 : 51.832 Start Lon : E 31 : 38.569
Finish Lat : S 12 : 51.832 Finish Lon : E 32 : 0.067
Length : 38.87 km

Transect # : 17A
Start Lat : S 12 : 53.182 Start Lon : E 31 : 59.256
Finish Lat : S 12 : 53.182 Finish Lon : E 31 : 58.689
Length : 1.02 km

Transect # : 17B
Start Lat : S 12 : 53.182 Start Lon : E 31 : 58.252
Finish Lat : S 12 : 53.182 Finish Lon : E 31 : 38.352
Length : 35.98 km

Transect # : 18A
Start Lat : S 12 : 54.532 Start Lon : E 31 : 38.135
Finish Lat : S 12 : 54.532 Finish Lon : E 31 : 55.478
Length : 31.36 km

Transect # : 18B
Start Lat : S 12 : 54.532 Start Lon : E 31 : 55.858
Finish Lat : S 12 : 54.532 Finish Lon : E 31 : 56.486
Length : 1.13 km

Transect # : 19A
Start Lat : S 12 : 55.882 Start Lon : E 31 : 55.288
Finish Lat : S 12 : 55.882 Finish Lon : E 31 : 54.872
Length : 0.75 km

Transect # : 19B
Start Lat : S 12 : 55.882 Start Lon : E 31 : 54.300
Finish Lat : S 12 : 55.882 Finish Lon : E 31 : 37.918
Length : 29.62 km

Transect # : 20
Start Lat : S 12 : 57.232 Start Lon : E 31 : 37.751
Finish Lat : S 12 : 57.232 Finish Lon : E 31 : 54.241
Length : 29.82 km

Transect # : 21A
Start Lat : S 12 : 58.582 Start Lon : E 31 : 53.456
Finish Lat : S 12 : 58.582 Finish Lon : E 31 : 43.898
Length : 17.28 km

Transect # : 21B
Start Lat : S 12 : 58.582 Start Lon : E 31 : 42.284
Finish Lat : S 12 : 58.582 Finish Lon : E 31 : 41.775
Length : 0.92 km

Transect # : 21C
Start Lat : S 12 : 58.582 Start Lon : E 31 : 38.736
Finish Lat : S 12 : 58.582 Finish Lon : E 31 : 37.953
Length : 1.42 km

Transect # : 22
Start Lat : S 12 : 59.932 Start Lon : E 31 : 45.568
Finish Lat : S 12 : 59.932 Finish Lon : E 31 : 54.012
Length : 15.27 km

Transect # : 23A
Start Lat : S 13 : 1.282 Start Lon : E 31 : 54.576
Finish Lat : S 13 : 1.282 Finish Lon : E 31 : 53.644
Length : 1.69 km

Transect # : 23B
Start Lat : S 13 : 1.282 Start Lon : E 31 : 53.325
Finish Lat : S 13 : 1.282 Finish Lon : E 31 : 45.639
Length : 13.90 km

Transect # : 24
Start Lat : S 13 : 2.632 Start Lon : E 31 : 45.982
Finish Lat : S 13 : 2.632 Finish Lon : E 31 : 51.775
Length : 10.48 km

Transect # : 25
Start Lat : S 13 : 3.982 Start Lon : E 31 : 50.593
Finish Lat : S 13 : 3.982 Finish Lon : E 31 : 45.907
Length : 8.47 km

Transect # : 26
Start Lat : S 13 : 5.332 Start Lon : E 31 : 45.199
Finish Lat : S 13 : 5.332 Finish Lon : E 31 : 48.610
Length : 6.17 km

Transect # : 27
Start Lat : S 13 : 6.682 Start Lon : E 31 : 45.906
Finish Lat : S 13 : 6.682 Finish Lon : E 31 : 45.702
Length : 0.37 km

4 Stratum

Number of transects : 21
Transect Bearing : 90.00 Degrees
Transect Spacing : 2.50 km

Transect # : 1
Start Lat : S 12 : 57.556 Start Lon : E 31 : 32.520
Finish Lat : S 12 : 57.556 Finish Lon : E 31 : 27.481
Length : 9.09 km

Transect # : 2A
Start Lat : S 12 : 58.906 Start Lon : E 31 : 27.757
Finish Lat : S 12 : 58.906 Finish Lon : E 31 : 34.251
Length : 11.72 km

Transect # : 2B
Start Lat : S 12 : 58.906 Start Lon : E 31 : 37.999
Finish Lat : S 12 : 58.906 Finish Lon : E 31 : 44.266
Length : 11.31 km

Transect # : 2C
Start Lat : S 12 : 58.906 Start Lon : E 31 : 44.268
Finish Lat : S 12 : 58.906 Finish Lon : E 31 : 45.223
Length : 1.72 km

Transect # : 3
Start Lat : S 13 : 0.256 Start Lon : E 31 : 45.296
Finish Lat : S 13 : 0.256 Finish Lon : E 31 : 28.474
Length : 30.36 km

Transect # : 4
Start Lat : S 13 : 1.606 Start Lon : E 31 : 28.578
Finish Lat : S 13 : 1.606 Finish Lon : E 31 : 45.728
Length : 30.96 km

Transect # : 5
Start Lat : S 13 : 2.956 Start Lon : E 31 : 45.934
Finish Lat : S 13 : 2.956 Finish Lon : E 31 : 29.163
Length : 30.27 km

Transect # : 6
Start Lat : S 13 : 4.306 Start Lon : E 31 : 29.067
Finish Lat : S 13 : 4.306 Finish Lon : E 31 : 45.895
Length : 30.38 km

Transect # : 7
Start Lat : S 13 : 5.656 Start Lon : E 31 : 44.344
Finish Lat : S 13 : 5.656 Finish Lon : E 31 : 28.524
Length : 28.55 km

Transect # : 8
Start Lat : S 13 : 7.006 Start Lon : E 31 : 28.616
Finish Lat : S 13 : 7.006 Finish Lon : E 31 : 44.088
Length : 27.93 km

Transect # : 9
Start Lat : S 13 : 8.356 Start Lon : E 31 : 44.016
Finish Lat : S 13 : 8.356 Finish Lon : E 31 : 27.791
Length : 29.29 km

Transect # : 10
Start Lat : S 13 : 9.706 Start Lon : E 31 : 27.367
Finish Lat : S 13 : 9.706 Finish Lon : E 31 : 43.862
Length : 29.77 km

Transect # : 11
Start Lat : S 13 : 11.056 Start Lon : E 31 : 43.017
Finish Lat : S 13 : 11.056 Finish Lon : E 31 : 27.160
Length : 28.62 km

Transect # : 12
Start Lat : S 13 : 12.406 Start Lon : E 31 : 27.652
Finish Lat : S 13 : 12.406 Finish Lon : E 31 : 41.065
Length : 24.21 km

Transect # : 13
Start Lat : S 13 : 13.756 Start Lon : E 31 : 38.979
Finish Lat : S 13 : 13.756 Finish Lon : E 31 : 27.622
Length : 20.50 km

Transect # : 14
Start Lat : S 13 : 15.106 Start Lon : E 31 : 27.332
Finish Lat : S 13 : 15.106 Finish Lon : E 31 : 38.905
Length : 20.89 km

Transect # : 15
Start Lat : S 13 : 16.456 Start Lon : E 31 : 39.541
Finish Lat : S 13 : 16.456 Finish Lon : E 31 : 27.939
Length : 20.94 km

Transect # : 16
Start Lat : S 13 : 17.806 Start Lon : E 31 : 28.607
Finish Lat : S 13 : 17.806 Finish Lon : E 31 : 39.047
Length : 18.84 km

Transect # : 17
Start Lat : S 13 : 19.156 Start Lon : E 31 : 38.988
Finish Lat : S 13 : 19.156 Finish Lon : E 31 : 29.405
Length : 17.30 km

Transect # : 18
Start Lat : S 13 : 20.506 Start Lon : E 31 : 30.413
Finish Lat : S 13 : 20.506 Finish Lon : E 31 : 38.502
Length : 14.60 km

Transect # : 19
Start Lat : S 13 : 21.856 Start Lon : E 31 : 37.031
Finish Lat : S 13 : 21.856 Finish Lon : E 31 : 31.514
Length : 9.96 km

Transect # : 20
Start Lat : S 13 : 23.206 Start Lon : E 31 : 31.812
Finish Lat : S 13 : 23.206 Finish Lon : E 31 : 34.528

Length : 4.90 km

Transect # : 21
Start Lat : S 13 : 24.556 Start Lon : E 31 : 33.054
Finish Lat : S 13 : 24.556 Finish Lon : E 31 : 32.968
Length : 0.16 km

5 Stratum

Number of transects : 19
Transect Bearing : 90.00 Degrees
Transect Spacing : 3.50 km

Transect # : 1
Start Lat : S 12 : 56.739 Start Lon : E 31 : 27.663
Finish Lat : S 12 : 56.739 Finish Lon : E 31 : 23.840
Length : 6.90 km

Transect # : 2
Start Lat : S 12 : 58.629 Start Lon : E 31 : 20.408
Finish Lat : S 12 : 58.629 Finish Lon : E 31 : 27.840
Length : 13.42 km

Transect # : 3
Start Lat : S 13 : 0.519 Start Lon : E 31 : 28.133
Finish Lat : S 13 : 0.519 Finish Lon : E 31 : 19.432
Length : 15.71 km

Transect # : 4
Start Lat : S 13 : 2.409 Start Lon : E 31 : 17.360
Finish Lat : S 13 : 2.409 Finish Lon : E 31 : 28.949
Length : 20.92 km

Transect # : 5
Start Lat : S 13 : 4.299 Start Lon : E 31 : 29.068
Finish Lat : S 13 : 4.299 Finish Lon : E 31 : 16.266
Length : 23.11 km

Transect # : 6
Start Lat : S 13 : 6.189 Start Lon : E 31 : 16.788
Finish Lat : S 13 : 6.189 Finish Lon : E 31 : 28.180
Length : 20.57 km

Transect # : 7
Start Lat : S 13 : 8.079 Start Lon : E 31 : 28.076
Finish Lat : S 13 : 8.079 Finish Lon : E 31 : 18.833
Length : 16.69 km

Transect # : 8
Start Lat : S 13 : 9.969 Start Lon : E 31 : 19.494
Finish Lat : S 13 : 9.969 Finish Lon : E 31 : 27.408
Length : 14.29 km

Transect # : 9
Start Lat : S 13 : 11.859 Start Lon : E 31 : 27.267
Finish Lat : S 13 : 11.859 Finish Lon : E 31 : 20.228
Length : 12.71 km

Transect # : 10
Start Lat : S 13 : 13.749 Start Lon : E 31 : 20.129
Finish Lat : S 13 : 13.749 Finish Lon : E 31 : 27.625
Length : 13.53 km

Transect # : 11
Start Lat : S 13 : 15.639 Start Lon : E 31 : 27.447
Finish Lat : S 13 : 15.639 Finish Lon : E 31 : 17.593
Length : 17.79 km

Transect # : 12
Start Lat : S 13 : 17.529 Start Lon : E 31 : 16.426
Finish Lat : S 13 : 17.529 Finish Lon : E 31 : 28.425
Length : 21.66 km

Transect # : 13
Start Lat : S 13 : 19.419 Start Lon : E 31 : 29.484
Finish Lat : S 13 : 19.419 Finish Lon : E 31 : 16.493
Length : 23.45 km

Transect # : 14
Start Lat : S 13 : 21.309 Start Lon : E 31 : 16.416
Finish Lat : S 13 : 21.309 Finish Lon : E 31 : 30.596
Length : 25.60 km

Transect # : 15
Start Lat : S 13 : 23.199 Start Lon : E 31 : 31.794
Finish Lat : S 13 : 23.199 Finish Lon : E 31 : 17.533
Length : 25.74 km

Transect # : 16
Start Lat : S 13 : 25.089 Start Lon : E 31 : 17.014
Finish Lat : S 13 : 25.089 Finish Lon : E 31 : 32.554
Length : 28.05 km

Transect # : 17
Start Lat : S 13 : 26.979 Start Lon : E 31 : 25.775
Finish Lat : S 13 : 26.979 Finish Lon : E 31 : 16.898
Length : 16.02 km

Transect # : 18
Start Lat : S 13 : 28.869 Start Lon : E 31 : 15.998
Finish Lat : S 13 : 28.869 Finish Lon : E 31 : 19.529
Length : 6.37 km

Transect # : 19
Start Lat : S 13 : 30.759 Start Lon : E 31 : 18.614
Finish Lat : S 13 : 30.759 Finish Lon : E 31 : 17.226
Length : 2.51 km

6 Lusiwasi

Number of transects : 17
Transect Bearing : 90.00 Degrees
Transect Spacing : 5.00 km

Transect # : 1
Start Lat : S 13 : 1.518 Start Lon : E 31 : 18.520
Finish Lat : S 13 : 1.518 Finish Lon : E 31 : 15.444
Length : 5.55 km

Transect # : 2
Start Lat : S 13 : 4.218 Start Lon : E 31 : 13.780
Finish Lat : S 13 : 4.218 Finish Lon : E 31 : 16.281
Length : 4.51 km

Transect # : 3
Start Lat : S 13 : 6.918 Start Lon : E 31 : 17.121
Finish Lat : S 13 : 6.918 Finish Lon : E 31 : 13.038
Length : 7.37 km

Transect # : 4
Start Lat : S 13 : 9.618 Start Lon : E 31 : 12.036
Finish Lat : S 13 : 9.618 Finish Lon : E 31 : 19.344
Length : 13.19 km

Transect # : 5
Start Lat : S 13 : 12.318 Start Lon : E 31 : 19.978
Finish Lat : S 13 : 12.318 Finish Lon : E 31 : 10.835
Length : 16.50 km

Transect # : 6
Start Lat : S 13 : 15.018 Start Lon : E 31 : 8.803
Finish Lat : S 13 : 15.018 Finish Lon : E 31 : 18.185
Length : 16.94 km

Transect # : 7
Start Lat : S 13 : 17.718 Start Lon : E 31 : 16.484
Finish Lat : S 13 : 17.718 Finish Lon : E 31 : 7.428
Length : 16.35 km

Transect # : 8
Start Lat : S 13 : 20.418 Start Lon : E 31 : 5.367
Finish Lat : S 13 : 20.418 Finish Lon : E 31 : 16.800
Length : 20.64 km

Transect # : 9
Start Lat : S 13 : 23.118 Start Lon : E 31 : 17.565
Finish Lat : S 13 : 23.118 Finish Lon : E 31 : 6.187
Length : 20.54 km

Transect # : 10
Start Lat : S 13 : 25.818 Start Lon : E 31 : 6.145
Finish Lat : S 13 : 25.818 Finish Lon : E 31 : 16.970
Length : 19.54 km

Transect # : 11
Start Lat : S 13 : 28.518 Start Lon : E 31 : 16.466
Finish Lat : S 13 : 28.518 Finish Lon : E 31 : 5.025
Length : 20.65 km

Transect # : 12
Start Lat : S 13 : 31.218 Start Lon : E 31 : 4.458
Finish Lat : S 13 : 31.218 Finish Lon : E 31 : 17.295
Length : 23.17 km

Transect # : 13
Start Lat : S 13 : 33.918 Start Lon : E 31 : 14.788
Finish Lat : S 13 : 33.918 Finish Lon : E 31 : 4.110
Length : 19.27 km

Transect # : 14
Start Lat : S 13 : 36.618 Start Lon : E 31 : 3.201
Finish Lat : S 13 : 36.618 Finish Lon : E 31 : 9.689
Length : 11.71 km

Transect # : 15
Start Lat : S 13 : 39.318 Start Lon : E 31 : 7.383
Finish Lat : S 13 : 39.318 Finish Lon : E 31 : 1.315
Length : 10.95 km

Transect # : 16
Start Lat : S 13 : 42.018 Start Lon : E 31 : 0.870
Finish Lat : S 13 : 42.018 Finish Lon : E 31 : 8.805
Length : 14.32 km

Transect # : 17A
Start Lat : S 13 : 44.718 Start Lon : E 31 : 4.521
Finish Lat : S 13 : 44.718 Finish Lon : E 31 : 1.914
Length : 4.71 km

Transect # : 17B
Start Lat : S 13 : 44.718 Start Lon : E 31 : 1.849
Finish Lat : S 13 : 44.718 Finish Lon : E 31 : 1.569
Length : 0.51 km

7 Chilongozi

Number of transects : 11
Transect Bearing : 90.00 Degrees
Transect Spacing : 3.50 km

Transect # : 1
Start Lat : S 13 : 25.616 Start Lon : E 31 : 27.969

Finish Lat : S 13 : 25.616 Finish Lon : E 31 : 26.523
Length : 2.61 km

Transect # : 2A
Start Lat : S 13 : 27.506 Start Lon : E 31 : 22.461
Finish Lat : S 13 : 27.506 Finish Lon : E 31 : 23.855
Length : 2.51 km

Transect # : 2B
Start Lat : S 13 : 27.506 Start Lon : E 31 : 25.655
Finish Lat : S 13 : 27.506 Finish Lon : E 31 : 33.688
Length : 14.48 km

Transect # : 3
Start Lat : S 13 : 29.396 Start Lon : E 31 : 33.476
Finish Lat : S 13 : 29.396 Finish Lon : E 31 : 19.037
Length : 26.02 km

Transect # : 4
Start Lat : S 13 : 31.286 Start Lon : E 31 : 18.392
Finish Lat : S 13 : 31.286 Finish Lon : E 31 : 34.150
Length : 28.40 km

Transect # : 5
Start Lat : S 13 : 33.176 Start Lon : E 31 : 34.197
Finish Lat : S 13 : 33.176 Finish Lon : E 31 : 15.038
Length : 34.53 km

Transect # : 6
Start Lat : S 13 : 35.066 Start Lon : E 31 : 13.922
Finish Lat : S 13 : 35.066 Finish Lon : E 31 : 33.643
Length : 35.54 km

Transect # : 7
Start Lat : S 13 : 36.956 Start Lon : E 31 : 32.758
Finish Lat : S 13 : 36.956 Finish Lon : E 31 : 8.818
Length : 43.14 km

Transect # : 8
Start Lat : S 13 : 38.846 Start Lon : E 31 : 7.262
Finish Lat : S 13 : 38.846 Finish Lon : E 31 : 28.712
Length : 38.65 km

Transect # : 9
Start Lat : S 13 : 40.736 Start Lon : E 31 : 23.495
Finish Lat : S 13 : 40.736 Finish Lon : E 31 : 7.536
Length : 28.76 km

Transect # : 10
Start Lat : S 13 : 42.626 Start Lon : E 31 : 7.542
Finish Lat : S 13 : 42.626 Finish Lon : E 31 : 18.278
Length : 19.35 km

Transect # : 11
Start Lat : S 13 : 44.516 Start Lon : E 31 : 13.061
Finish Lat : S 13 : 44.516 Finish Lon : E 31 : 7.042
Length : 10.85 km

8 Nsefu

Number of transects : 5
Transect Bearing : 90.00 Degrees
Transect Spacing : 3.50 km

Transect # : 1A
Start Lat : S 13 : 0.123 Start Lon : E 31 : 53.919
Finish Lat : S 13 : 0.123 Finish Lon : E 31 : 54.961
Length : 1.88 km

Transect # : 1B
Start Lat : S 13 : 0.123 Start Lon : E 31 : 59.052
Finish Lat : S 13 : 0.123 Finish Lon : E 32 : 6.991
Length : 14.34 km

Transect # : 2A
Start Lat : S 12 : 58.233 Start Lon : E 32 : 5.623
Finish Lat : S 12 : 58.233 Finish Lon : E 31 : 57.716
Length : 14.28 km

Transect # : 2B
Start Lat : S 12 : 58.233 Start Lon : E 31 : 56.872
Finish Lat : S 12 : 58.233 Finish Lon : E 31 : 56.766
Length : 0.19 km

Transect # : 2C
Start Lat : S 12 : 58.233 Start Lon : E 31 : 56.096
Finish Lat : S 12 : 58.233 Finish Lon : E 31 : 53.975
Length : 3.83 km

Transect # : 3
Start Lat : S 12 : 56.343 Start Lon : E 31 : 54.240
Finish Lat : S 12 : 56.343 Finish Lon : E 32 : 4.327
Length : 18.22 km

Transect # : 4A
Start Lat : S 12 : 54.453 Start Lon : E 32 : 3.059
Finish Lat : S 12 : 54.453 Finish Lon : E 31 : 56.514
Length : 11.82 km

Transect # : 4B
Start Lat : S 12 : 54.453 Start Lon : E 31 : 55.828
Finish Lat : S 12 : 54.453 Finish Lon : E 31 : 55.510
Length : 0.57 km

Transect # : 5A
Start Lat : S 12 : 52.563 Start Lon : E 31 : 57.928
Finish Lat : S 12 : 52.563 Finish Lon : E 31 : 58.472
Length : 0.98 km

Transect # : 5B

Start Lat : S 12 : 52.563 Start Lon : E 31 : 58.983
Finish Lat : S 12 : 52.563 Finish Lon : E 31 : 59.371
Length : 0.70 km

Transect # : 5C
Start Lat : S 12 : 52.563 Start Lon : E 32 : 0.042
Finish Lat : S 12 : 52.563 Finish Lon : E 32 : 1.185
Length : 2.06 km

9 Upper Lupande

Number of transects : 5
Transect Bearing : 90.00 Degrees
Transect Spacing : 4.00 km

Transect # : 1
Start Lat : S 13 : 7.873 Start Lon : E 32 : 15.000
Finish Lat : S 13 : 7.873 Finish Lon : E 31 : 54.651
Length : 36.75 km

Transect # : 2A
Start Lat : S 13 : 5.713 Start Lon : E 31 : 48.679
Finish Lat : S 13 : 5.713 Finish Lon : E 31 : 53.712
Length : 9.09 km

Transect # : 2B
Start Lat : S 13 : 5.713 Start Lon : E 31 : 53.751
Finish Lat : S 13 : 5.713 Finish Lon : E 32 : 15.000
Length : 38.37 km

Transect # : 3
Start Lat : S 13 : 3.553 Start Lon : E 32 : 15.000
Finish Lat : S 13 : 3.553 Finish Lon : E 31 : 50.817
Length : 43.67 km

Transect # : 4A
Start Lat : S 13 : 1.393 Start Lon : E 31 : 53.199
Finish Lat : S 13 : 1.393 Finish Lon : E 31 : 53.855
Length : 1.18 km

Transect # : 4B
Start Lat : S 13 : 1.393 Start Lon : E 31 : 54.572
Finish Lat : S 13 : 1.393 Finish Lon : E 32 : 15.000
Length : 36.89 km

Transect # : 5A
Start Lat : S 12 : 59.233 Start Lon : E 32 : 12.729
Finish Lat : S 12 : 59.233 Finish Lon : E 32 : 6.328
Length : 11.56 km

Transect # : 5B
Start Lat : S 12 : 59.233 Start Lon : E 31 : 58.139
Finish Lat : S 12 : 59.233 Finish Lon : E 31 : 56.141
Length : 3.61 km

10 West Lower Lupande

Number of transects : 14
Transect Bearing : 90.00 Degrees
Transect Spacing : 3.00 km

Transect # : 1
Start Lat : S 13 : 31.484 Start Lon : E 31 : 34.219
Finish Lat : S 13 : 31.484 Finish Lon : E 31 : 38.969
Length : 8.57 km

Transect # : 2
Start Lat : S 13 : 29.864 Start Lon : E 31 : 38.977
Finish Lat : S 13 : 29.864 Finish Lon : E 31 : 33.484
Length : 9.91 km

Transect # : 3
Start Lat : S 13 : 28.244 Start Lon : E 31 : 33.708
Finish Lat : S 13 : 28.244 Finish Lon : E 31 : 39.298
Length : 10.08 km

Transect # : 4
Start Lat : S 13 : 26.624 Start Lon : E 31 : 39.539
Finish Lat : S 13 : 26.624 Finish Lon : E 31 : 33.683
Length : 10.56 km

Transect # : 5
Start Lat : S 13 : 25.004 Start Lon : E 31 : 32.583
Finish Lat : S 13 : 25.004 Finish Lon : E 31 : 39.299
Length : 12.11 km

Transect # : 6
Start Lat : S 13 : 23.384 Start Lon : E 31 : 39.420
Finish Lat : S 13 : 23.384 Finish Lon : E 31 : 34.433
Length : 8.99 km

Transect # : 7
Start Lat : S 13 : 21.764 Start Lon : E 31 : 37.044
Finish Lat : S 13 : 21.764 Finish Lon : E 31 : 40.042
Length : 5.41 km

Transect # : 8
Start Lat : S 13 : 20.144 Start Lon : E 31 : 40.463
Finish Lat : S 13 : 20.144 Finish Lon : E 31 : 38.351
Length : 3.81 km

Transect # : 9
Start Lat : S 13 : 18.524 Start Lon : E 31 : 39.558
Finish Lat : S 13 : 18.524 Finish Lon : E 31 : 40.447
Length : 1.60 km

Transect # : 10
Start Lat : S 13 : 16.904 Start Lon : E 31 : 40.682
Finish Lat : S 13 : 16.904 Finish Lon : E 31 : 39.562
Length : 2.02 km

Transect # : 11
Start Lat : S 13 : 15.284 Start Lon : E 31 : 39.014
Finish Lat : S 13 : 15.284 Finish Lon : E 31 : 40.668
Length : 2.98 km

Transect # : 12
Start Lat : S 13 : 13.664 Start Lon : E 31 : 41.658
Finish Lat : S 13 : 13.664 Finish Lon : E 31 : 39.091
Length : 4.63 km

Transect # : 13
Start Lat : S 13 : 12.044 Start Lon : E 31 : 41.956
Finish Lat : S 13 : 12.044 Finish Lon : E 31 : 44.290
Length : 4.21 km

Transect # : 14
Start Lat : S 13 : 10.424 Start Lon : E 31 : 44.198
Finish Lat : S 13 : 10.424 Finish Lon : E 31 : 43.035
Length : 2.10 km

11 East Lower Lupande

Number of transects : 10
Transect Bearing : 90.00 Degrees
Transect Spacing : 6.00 km

Transect # : 1
Start Lat : S 13 : 37.687 Start Lon : E 31 : 54.425
Finish Lat : S 13 : 37.687 Finish Lon : E 31 : 49.756
Length : 8.42 km

Transect # : 2
Start Lat : S 13 : 34.447 Start Lon : E 31 : 47.578
Finish Lat : S 13 : 34.447 Finish Lon : E 31 : 54.956
Length : 13.31 km

Transect # : 3
Start Lat : S 13 : 31.207 Start Lon : E 31 : 55.949
Finish Lat : S 13 : 31.207 Finish Lon : E 31 : 47.921
Length : 14.48 km

Transect # : 4
Start Lat : S 13 : 27.967 Start Lon : E 31 : 49.266
Finish Lat : S 13 : 27.967 Finish Lon : E 31 : 57.082
Length : 14.10 km

Transect # : 5
Start Lat : S 13 : 24.727 Start Lon : E 31 : 55.721
Finish Lat : S 13 : 24.727 Finish Lon : E 31 : 49.194
Length : 11.77 km

Transect # : 6
Start Lat : S 13 : 21.487 Start Lon : E 31 : 47.005
Finish Lat : S 13 : 21.487 Finish Lon : E 31 : 55.707
Length : 15.70 km

Transect # : 7
Start Lat : S 13 : 18.247 Start Lon : E 31 : 55.409
Finish Lat : S 13 : 18.247 Finish Lon : E 31 : 45.779
Length : 17.37 km

Transect # : 8
Start Lat : S 13 : 15.007 Start Lon : E 31 : 45.056
Finish Lat : S 13 : 15.007 Finish Lon : E 31 : 54.792
Length : 17.56 km

Transect # : 9
Start Lat : S 13 : 11.767 Start Lon : E 31 : 50.228
Finish Lat : S 13 : 11.767 Finish Lon : E 31 : 44.274
Length : 10.74 km

Transect # : 10
Start Lat : S 13 : 8.527 Start Lon : E 31 : 43.928
Finish Lat : S 13 : 8.527 Finish Lon : E 31 : 51.112
Length : 12.96 km

12 Machinje

Number of transects : 4
Transect Bearing : 0.00 Degrees
Transect Spacing : 5.00 km

Transect # : 1
Start Lat : S 13 : 3.227 Start Lon : E 32 : 26.009
Finish Lat : S 13 : 2.385 Finish Lon : E 32 : 26.009
Length : 1.56 km

Transect # : 2
Start Lat : S 13 : 1.727 Start Lon : E 32 : 23.238
Finish Lat : S 13 : 9.589 Finish Lon : E 32 : 23.238
Length : 14.56 km

Transect # : 3
Start Lat : S 13 : 9.589 Start Lon : E 32 : 20.468

Finish Lat : S 13 : 1.070 Finish Lon : E 32 : 20.468
Length : 15.78 km

Transect # : 4
Start Lat : S 13 : 0.412 Start Lon : E 32 : 17.697
Finish Lat : S 13 : 9.589 Finish Lon : E 32 : 17.697
Length : 16.99 km

13 East Lupande

Number of transects : 6
Transect Bearing : 90.00 Degrees
Transect Spacing : 10.00 km

Transect # : 1
Start Lat : S 13 : 33.985 Start Lon : E 32 : 0.187
Finish Lat : S 13 : 33.985 Finish Lon : E 31 : 55.094
Length : 9.19 km

Transect # : 2
Start Lat : S 13 : 28.585 Start Lon : E 31 : 57.155
Finish Lat : S 13 : 28.585 Finish Lon : E 32 : 3.494
Length : 11.44 km

Transect # : 3
Start Lat : S 13 : 23.185 Start Lon : E 32 : 19.684
Finish Lat : S 13 : 23.185 Finish Lon : E 31 : 54.992
Length : 44.55 km

Transect # : 4
Start Lat : S 13 : 17.785 Start Lon : E 31 : 55.343
Finish Lat : S 13 : 17.785 Finish Lon : E 32 : 21.441
Length : 47.09 km

Transect # : 5
Start Lat : S 13 : 12.385 Start Lon : E 32 : 23.198
Finish Lat : S 13 : 12.385 Finish Lon : E 31 : 49.910
Length : 60.06 km

Transect # : 6A
Start Lat : S 13 : 6.985 Start Lon : E 31 : 49.060
Finish Lat : S 13 : 6.985 Finish Lon : E 31 : 49.725
Length : 1.20 km

Transect # : 6B
Start Lat : S 13 : 6.985 Start Lon : E 31 : 51.670
Finish Lat : S 13 : 6.985 Finish Lon : E 31 : 54.250
Length : 4.66 km

14 Lupande Hills

Number of transects : 7
Transect Bearing : 0.00 Degrees
Transect Spacing : 5.00 km

Transect # : 1
Start Lat : S 13 : 39.019 Start Lon : E 31 : 51.703
Finish Lat : S 13 : 49.065 Finish Lon : E 31 : 51.703
Length : 18.60 km

Transect # : 2A
Start Lat : S 13 : 48.999 Start Lon : E 31 : 48.930
Finish Lat : S 13 : 36.981 Finish Lon : E 31 : 48.930
Length : 22.26 km

Transect # : 2B
Start Lat : S 13 : 28.883 Start Lon : E 31 : 48.930
Finish Lat : S 13 : 24.349 Finish Lon : E 31 : 48.930
Length : 8.40 km

Transect # : 3
Start Lat : S 13 : 19.357 Start Lon : E 31 : 46.157
Finish Lat : S 13 : 48.933 Finish Lon : E 31 : 46.157
Length : 54.77 km

Transect # : 4
Start Lat : S 13 : 40.806 Start Lon : E 31 : 43.384
Finish Lat : S 13 : 14.720 Finish Lon : E 31 : 43.384
Length : 48.09 km

Transect # : 5
Start Lat : S 13 : 17.337 Start Lon : E 31 : 40.612
Finish Lat : S 13 : 37.971 Finish Lon : E 31 : 40.612
Length : 38.21 km

Transect # : 6
Start Lat : S 13 : 36.092 Start Lon : E 31 : 37.839
Finish Lat : S 13 : 33.000 Finish Lon : E 31 : 37.839
Length : 5.73 km

Transect # : 7
Start Lat : S 13 : 33.000 Start Lon : E 31 : 35.066
Finish Lat : S 13 : 35.641 Finish Lon : E 31 : 35.066
Length : 4.89 km

Appendix 4. Transect Summaries.

Species codes:

Code	Species
Bbk	Bushbuck
Buff	Buffalo
Dkr	Common Duiker
ElC3	Elephant carcass, age category 3
Eld	Eland
EleF	Elephant cow
EleM	Elephant bull
Ghb	Ground hornbill
Grf	Thornicroft's Giraffe
Hbst	Lichtenstein's Hartebeest
Imp	Impala
Kudu	Kudu
PCmp	Poachers' camp
Puku	Puku
Rbk	Reedbuck
Roan	Roan antelope
Shoa	Sheep and/or goats
Wbck	Waterbuck
Wbst	Cookson's Wildebeest
Whog	Warthog
UnCa	Unidentified carcass
Zeb	Zebra

Other abbreviations

Abbreviation	Meaning
n	number of transects sampled
N	possible number of transects in stratum
t	Student's *t* value, $P = 0.05$
T #	transect number
-	no animals seen in strips

Date of Survey : 13/08/02
Stratum Locality : South Luangwa NP
Stratum Area : 556 km^2
N : 133 n : 12
Pilot : J. Cadd
Map overlay file : None

Stratum Name : Chifungwe
Base Line Length : 43 km
Calibrated Strip Width at 300ft : 318 m
t : 2.201
Observer : P Zyambo, W Moonga

Transect summary table :

T #	EleM	EleF	Zeb	Wbck	Imp	Kudu	Wbst	Bbk	Ghb	Whog	Hbst	Puku	Rbk	UnCa
1	-	-	-	-	-	-	1	-	-	-	-	-	-	-
2	-	6	-	-	50	-	-	-	-	7	-	-	-	-
3	-	17	12	6	25	-	-	1	4	5	-	-	-	-
4	2	42	2	2	12	-	-	-	-	-	-	8	2	-
5	-	-	-	-	-	-	-	-	-	-	-	-	4	-
6	-	4	4	-	35	10	-	-	-	2	6	-	-	-
7	-	-	3	-	-	-	-	-	-	-	-	-	2	1
8	-	-	-	-	-	-	-	-	-	9	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	2	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Zeb	Wbck	Imp	Kudu	Wbst	Bbk	Ghb	Whog	Hbst	Puku	Rbk	UnCa
	2	69	21	8	122	10	1	1	4	25	6	8	8	1

Date of Survey : 13/08/02
Stratum Locality : South Luangwa NP
Stratum Area : 1222 km^2
N : 169 n : 11
Pilot : J. Cadd
Map overlay file : None

Stratum Name : Nosbara
Base Line Length : 54.2 km
Calibrated Strip Width at 300ft : 318 m
t : 2.228
Observer : P Zyambo, W Moonga

Transect summary table :

T #	Zeb	Kudu	Whog	Rbk	Bbk	Ghb
1	5	5	2	-	-	-
2	-	-	-	-	-	-
3	-	-	-	-	-	-
4	-	-	-	-	-	-
5	4	-	-	-	-	-
6	-	-	-	2	-	-
7	-	-	-	-	-	-
8	-	-	-	-	1	3
9	-	-	-	-	-	-
10	-	-	-	-	-	-
11	-	-	-	-	-	-

Sighting Totals

	Zeb	Kudu	Whog	Rbk	Bbk	Ghb
	9	5	2	2	1	3

Date of Survey : 14/08/02
Stratum Name : Lubi
Stratum Locality : South Luangwa NP
Base Line Length : 66.9 km
Stratum Area : 1961 km^2
Calibrated Strip Width at 300ft : 318 m
N : 204 n : 27 t : 2.056
Pilot : J. Cadd
Observer : P Zyambo, W Moonga
Map overlay file : None

Transect summary table :

T #	EleM	EleF	Buff	Zeb	Wbck	Imp	Kudu	UnCa	Rbk	Whog	Eld	Puku	Ghb	Grf	PCmp	Roan	Hbst	Bbk
1	-	-	-	4	-	44	-	-	1	6	2	2	3	-	-	-	-	-
2	-	-	5	-	-	3	-	-	-	-	-	8	-	-	-	-	-	-
3	-	-	9	8	-	43	-	-	-	8	-	-	-	-	-	-	-	-
4	-	-	-	8	-	30	-	-	2	1	-	1	-	-	-	-	-	-
5	-	-	-	12	-	99	-	-	2	-	-	-	-	-	-	-	-	-
6	-	-	-	11	5	7	6	-	-	4	-	-	-	-	-	-	-	-
7	-	-	50	21	4	39	-	-	-	-	-	6	-	-	-	-	-	-
8	-	-	4	-	-	11	-	-	1	-	-	11	-	-	-	-	-	-
9	-	6	31	7	-	24	-	-	-	-	-	26	-	-	-	-	-	2
10	-	6	-	53	11	4	3	-	-	-	-	14	-	1	2	-	-	-
11	-	-	-	9	-	28	3	-	-	-	1	17	3	-	-	-	-	-
12	1	18	-	24	-	4	-	-	-	-	-	10	-	-	-	9	-	-
13	-	-	-	6	-	13	-	-	-	2	-	-	3	-	-	-	-	-
14	-	5	34	22	1	57	-	-	6	2	10	24	-	-	-	-	2	-
15	-	-	98	7	-	11	-	-	-	-	-	23	6	-	-	-	-	-
16	-	4	-	3	2	53	-	-	-	4	-	26	-	-	-	-	-	-
17	-	-	2	13	-	18	-	-	-	4	2	11	-	-	-	-	-	-
18	-	35	-	4	4	62	-	-	-	-	-	10	-	-	1	-	-	-
19	2	57	-	2	-	8	-	-	-	-	-	-	-	5	-	1	-	-
20	3	46	561	22	1	35	-	1	2	5	5	20	-	-	-	-	3	-
21	-	18	-	2	-	-	-	-	-	-	-	-	-	-	-	-	5	-
22	1	7	-	10	-	25	-	-	-	1	-	8	-	-	-	-	-	-
23	-	9	-	11	4	22	-	-	-	-	-	7	-	4	-	-	-	-
24	-	-	-	18	1	61	-	-	-	3	-	-	-	-	-	-	-	-
25	-	-	-	3	4	5	-	-	-	-	-	4	-	-	-	-	-	-
26	-	3	-	-	4	24	-	-	-	-	-	41	-	3	-	-	-	-
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Buff	Zeb	Wbck	Imp	Kudu	UnCa	Rbk	Whog	Eld	Puku	Ghb	Grf	PCmp	Roan	Hbst	Bbk
	7	214	794	280	41	730	12	1	14	40	20	269	15	13	3	10	10	2

Date of Survey : 15/08/02
Stratum Name : Stratum 4
Stratum Locality : South Luangwa NP
Base Line Length : 51 km
Stratum Area : 1128 km^2
Calibrated Strip Width at 300ft : 318 m
N : 156 n : 21
t : 2.086
Pilot : J. Cadd
Observer : W Moonga, P Zyambo
Map overlay file : None

Transect summary table :

T #	EleM	EleF	Buff	Zeb	Wbck	Imp	UnCa	Hbst	Whog	Puku	Roan	Grf	PCmp
1	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	4	-	9	-	4	1	-	-	-	-
3	-	4	-	-	-	-	-	-	-	-	-	-	-
4	-	24	-	-	-	-	-	-	-	-	-	-	-
5	2	3	-	2	-	-	-	-	-	-	-	-	-
6	-	-	-	1	-	4	-	-	-	-	-	-	-
7	-	13	-	-	-	15	-	-	-	7	-	-	-
8	-	7	-	2	-	-	-	-	-	-	2	-	-
9	-	-	-	-	-	40	-	-	4	15	1	2	1
10	-	14	41	-	1	32	-	-	3	8	-	-	-
11	-	16	-	-	-	3	-	-	-	4	-	-	-
12	-	3	-	-	-	-	-	-	-	-	2	-	1
13	-	-	-	-	-	-	-	-	-	-	-	-	-
14	-	4	-	-	-	4	-	-	-	-	-	-	-
15	1	2	35	-	-	-	-	-	-	-	-	-	-
16	1	9	-	-	-	6	-	-	5	-	-	-	-
17	-	2	-	-	-	-	1	-	-	-	-	-	-
18	-	3	-	-	-	-	-	-	7	3	-	-	-
19	-	3	-	-	1	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	5	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Buff	Zeb	Wbck	Imp	UnCa	Hbst	Whog	Puku	Roan	Grf	PCmp
	4	107	76	9	2	113	1	4	20	42	5	2	2

Date of Survey : 17/08/02
Stratum Name : Stratum 5
Stratum Locality : South Luangwa NP
Base Line Length : 65.4 km
Stratum Area : 1127 km^2
Calibrated Strip Width at 300ft : 318 m
N : 203 n : 19
t : 2.101
Pilot : J. Cadd
Observer : P Zyambo, W Moonga
Map overlay file : None

Transect summary table :

T #	EleM	EleF	Buff	Zeb	Wbck	Imp	Kudu	Whog	Ghb	Roan	PCmp	Puku
1	-	-	2	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	3	-	-	-	-	1	-	-	-	-
4	-	-	-	-	-	-	-	-	3	-	-	-
5	-	-	35	-	-	-	-	1	-	-	-	-
6	-	-	-	-	-	-	-	-	-	1	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	7	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-	-
12	-	-	-	5	3	-	-	-	-	-	-	-
13	-	11	-	-	-	-	6	-	-	-	-	-
14	-	11	-	-	-	-	-	1	1	-	1	-
15	3	3	-	-	-	-	-	-	-	-	-	-
16	-	9	-	-	-	15	-	-	-	-	1	10
17	-	12	-	-	-	10	-	-	-	-	-	-
18	-	-	-	-	-	-	-	3	-	-	-	2
19	-	-	-	-	-	6	-	-	-	-	-	8

Sighting Totals

	EleM	EleF	Buff	Zeb	Wbck	Imp	Kudu	Whog	Ghb	Roan	PCmp	Puku
	3	46	40	5	3	31	6	6	4	8	2	20

Date of Survey : 19/08/02
Stratum Name : Lusiwasi
Stratum Locality : South Luangwa NP
Base Line Length : 87.9 km
Stratum Area : 1224 km^2
Calibrated Strip Width at 300ft : 318 m
N : 269 n : 17
t : 2.12
Pilot : J. Cadd
Observer : P Zyambo, W Moonga
Map overlay file : None

Transect summary table :

T #	Buff	Zeb	Wbck	Imp	Ghb	Whog	Roan	Dkr	Bbk
1	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-
5	-	-	-	-	3	-	-	-	1
6	-	-	-	-	-	-	-	-	3
7	6	6	-	-	-	2	-	-	-
8	-	3	4	9	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-
11	-	-	-	2	-	-	-	-	-
12	-	-	-	-	-	-	1	1	-
13	-	-	-	-	-	-	-	-	-
14	-	2	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-
16	-	4	-	-	-	2	-	-	-
17	-	-	-	-	-	-	-	-	-

Sighting Totals

	Buff	Zeb	Wbck	Imp	Ghb	Whog	Roan	Dkr	Bbk
	6	15	4	11	3	4	1	1	4

Date of Survey : 18/08/02
Stratum Locality : South Luangwa NP
Stratum Area : 1004 km^2
N : 116 n : 11
Pilot : J. Cadd
Map overlay file : None

Stratum Name : Chilongozi
Base Line Length : 38.3 km
Calibrated Strip Width at 300ft : 318 m
t : 2.228
Observer : P Zyambo, W Moonga

Transect summary table :

T #	EleM	EleF	Buff	Zeb	Imp	Kudu	EIC3	Whog	Puku	Ghb	Grf
1	-	-	-	-	55	-	-	-	-	-	-
2	3	17	-	-	8	-	-	5	-	-	-
3	-	-	50	-	11	-	1	-	4	2	-
4	1	6	-	-	-	-	-	2	-	-	-
5	-	3	-	-	-	-	-	-	-	-	-
6	-	7	-	-	-	-	-	-	-	-	-
7	-	-	-	5	-	-	-	-	-	-	1
8	-	-	-	4	-	-	-	-	2	-	2
9	-	-	8	-	-	2	-	-	1	-	1
10	-	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Buff	Zeb	Imp	Kudu	EIC3	Whog	Puku	Ghb	Grf
	4	33	58	9	74	2	1	7	7	2	4

Date of Survey : 18/08/02
Stratum Locality : South Luangwa NP
Stratum Area : 226 km^2
N : 51 n : 5
Pilot : J. Cadd
Map overlay file : None

Stratum Name : Nsefu
Base Line Length : 16.3 km
Calibrated Strip Width at 300ft : 318 m
t : 2.776
Observer : P Zyambo, W Moonga

Transect summary table :

T #	EleM	EleF	Buff	Zeb	Wbck	Imp	Kudu	EIC3	UnCa	Puku	Whog	Ghb	Grf
1	-	3	-	-	-	43	-	-	-	3	-	-	-
2	-	10	3	-	1	4	1	-	1	10	4	-	-
3	-	-	50	1	-	31	-	1	-	63	7	1	-
4	-	5	2	-	-	7	-	-	-	81	-	-	2
5	1	3	-	-	-	34	-	-	-	41	3	-	1

Sighting Totals

	EleM	EleF	Buff	Zeb	Wbck	Imp	Kudu	EIC3	UnCa	Puku	Whog	Ghb	Grf
	1	21	55	1	1	119	1	1	1	198	14	1	3

Date of Survey : 17/08/02
Stratum Locality : Lupande GMA
Stratum Area : 765 km^2
N : 69 n : 5
Pilot : J. Cadd
Map overlay file : None

Stratum Name : Upper Lupande
Base Line Length : 22.5 km
Calibrated Strip Width at 300ft : 318 m
t : 2.776
Observer : P Zyambo, W Moonga

Transect summary table :

T #	EleM	EleF	Buff	Zeb	Imp	Kudu	Wbst	Puku	Whog	Eld	EIC3
1	-	-	46	-	-	-	-	-	-	-	-
2	-	-	6	18	-	1	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	1
4	2	6	-	-	63	7	40	24	1	4	-
5	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Buff	Zeb	Imp	Kudu	Wbst	Puku	Whog	Eld	EIC3
	2	6	52	18	63	8	40	24	1	4	1

Date of Survey : 15/08/02
Stratum Locality : Lupande GMA
Stratum Area : 274 km^2
N : 134 n : 14
Pilot : J. Cadd
Map overlay file : None

Stratum Name : West Lower Lupande
Base Line Length : 43.6 km
Calibrated Strip Width at 300ft : 318 m
t : 2.16
Observer : W Moonga, P Zyambo

Transect summary table :

T #	EleM	EleF	Zeb	Wbck	Imp	Ghb	Puku	Grf	Whog
1	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-
3	-	8	2	-	-	-	-	-	-
4	-	7	-	-	-	1	-	-	-
5	-	15	-	1	-	-	-	-	-
6	-	23	-	-	-	-	-	-	-
7	-	-	-	-	-	-	21	4	-
8	-	-	-	-	22	-	-	-	1
9	-	-	-	-	-	-	-	-	-
10	-	-	-	-	25	-	3	-	-
11	1	3	3	-	-	-	3	-	-
12	-	3	-	1	1	-	4	-	-
13	-	-	-	-	-	-	-	-	-
14	-	-	-	-	8	-	18	1	-

Sighting Totals

	EleM	EleF	Zeb	Wbck	Imp	Ghb	Puku	Grf	Whog
	1	59	5	2	56	1	49	5	1

Date of Survey : 13/08/02
Stratum Locality : Lupande GMA
Stratum Area : 816 km^2
N : 196 n : 10
Pilot : J. Cadd
Map overlay file : None

Stratum Name : East Lower Lupande
Base Line Length : 63.3 km
Calibrated Strip Width at 300ft : 318 m
t : 2.262
Observer : P Zyambo, W Moonga

Transect summary table :

T #	EleM	EleF	Wbck	Imp	EIC3	Pig	Puku	Bbk	Shoa
1	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	1	15
3	2	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-
6	-	-	-	3	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	1	-	-	-
9	-	-	-	-	-	-	-	-	-
10	-	10	2	6	2	-	6	-	-

Sighting Totals

	EleM	EleF	Wbck	Imp	EIC3	Pig	Puku	Bbk	Shoa
	2	10	2	9	2	1	6	1	15

Date of Survey : 17/08/02
Stratum Locality : Lupande GMA
Stratum Area : 295 km^2
N : 68 n : 4
Pilot : J. Cadd
Map overlay file : None

Stratum Name : Machinje
Base Line Length : 22.2 km
Calibrated Strip Width at 300ft : 318 m
t : 3.182
Observer : P Zyambo, W Moonga

Transect summary table :

T #	Roan	Hbst
1	-	-
2	-	-
3	6	4
4	-	2

Sighting Totals

	Roan	Hbst
	6	6

Date of Survey : 12/08/02
Stratum Locality : Lupande GMA
Stratum Area : 1797 km^2
N : 178 n : 6
Pilot : J. Cadd
Map overlay file : None

Stratum Name : East Lupande
Base Line Length : 58.1 km
Calibrated Strip Width at 300ft : 318 m
t : 2.571
Observer : P Zyambo, W Moonga

Transect summary table :

T #	Buff	Shoa	Ghb	Roan
1	-	-	-	-
2	-	-	2	-
3	-	-	2	-
4	-	10	-	-
5	10	12	-	8
6	-	-	-	-

Sighting Totals

	Buff	Shoa	Ghb	Roan
	10	22	4	8

Date of Survey : 18/08/02
Stratum Locality : Lupande Hills
Stratum Area : 1012 km^2
N : 104 n : 7
Pilot : J. Cadd
Map overlay file : None

Stratum Name : Lupande Hills
Base Line Length : 36.9 km
Calibrated Strip Width at 300ft : 318 m
t : 2.447
Observer : P Zyambo, W Moonga

Transect summary table :

T #	EleF	Zeb	Imp	Kudu	Shoa	Roan
1	-	-	-	-	-	-
2	-	-	2	-	15	-
3	-	-	-	2	-	4
4	5	1	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
7	-	-	-	-	-	-

Sighting Totals

	EleF	Zeb	Imp	Kudu	Shoa	Roan
	5	1	2	2	15	4

Appendix 5. Position data for sightings in Lupande GMA.

Longitude °E	Latitude °S	Species	Group Size
31.10733	13.13122	buffalo	1
31.82300	13.09522	buffalo	1
31.82300	13.09522	buffalo	5
32.06100	13.20641	buffalo	10
31.14167	13.13122	buffalo	45
31.90867	13.57412	bushbuck	1
31.97000	13.02322	eland	4
31.65817	13.25473	elephant bulls	1
31.89400	13.02322	elephant bulls	2
31.81850	13.52012	elephant bulls	2
31.55400	13.41673	elephant cows	1
31.55400	13.41673	elephant cows	2
31.72307	13.25883	elephant cows	2
31.57283	13.38973	elephant cows	3
31.65167	13.25473	elephant cows	3
31.68933	13.22773	elephant cows	3
31.75767	13.14212	elephant cows	3
31.72307	13.24533	elephant cows	3
31.57283	13.38973	elephant cows	4
31.61917	13.41673	elephant cows	5
32.21117	13.02322	elephant cows	6
31.57550	13.44373	elephant cows	7
31.58233	13.41673	elephant cows	7
31.75100	13.14212	elephant cows	7
31.56667	13.47074	elephant cows	8
31.57350	13.38973	elephant cows	16
31.72500	13.17373	giraffe	1
31.62400	13.36273	giraffe	4
31.62400	13.44373	ground hornbill	1
31.99283	13.47641	ground hornbill	2
32.02967	13.38641	ground hornbill	2
32.29495	13.08417	hartebeest	2
32.34113	13.04350	hartebeest	4
32.01700	13.02322	impala	1
31.67583	13.22773	impala	1
32.00167	13.02322	impala	2
31.81550	13.67500	impala	2
31.85567	13.35812	impala	3
32.01700	13.02322	impala	4
32.04200	13.02322	impala	4
31.75767	13.14212	impala	6
31.95850	13.02322	impala	7
31.97000	13.02322	impala	8
31.72500	13.17373	impala	8
31.92383	13.02322	impala	14
31.64950	13.33573	impala	22
31.91933	13.02322	impala	23
31.66800	13.28173	impala	25
32.20917	13.09522	kudu	1
31.76929	13.72967	kudu	2

Longitude °E	Latitude °S	Species	Group Size
32.16750	13.02322	kudu	7
32.05500	13.05922	elephant carcass, old	1
31.75100	13.14212	elephant carcass, old	1
31.75767	13.14212	elephant carcass, old	1
31.91700	13.25012	pig, domestic	1
31.91933	13.02322	puku	1
31.65917	13.28173	puku	3
31.65817	13.25473	puku	3
31.67583	13.22773	puku	4
31.91933	13.02322	puku	5
31.78300	13.14212	puku	6
31.62400	13.36273	puku	9
31.62400	13.36273	puku	12
31.89400	13.02322	puku	18
31.71683	13.17373	puku	18
31.76929	13.37633	roan	4
32.34113	13.14100	roan	6
32.16583	13.20641	roan	8
31.93033	13.20641	sheep &/or goats	4
31.93567	13.20641	sheep &/or goats	8
32.05417	13.29641	sheep &/or goats	10
31.90867	13.57412	sheep &/or goats	15
31.81550	13.67500	sheep &/or goats	15
32.08867	13.02322	warthog	1
31.63717	13.33573	warthog	1
31.56817	13.41673	waterbuck	1
31.68933	13.22773	waterbuck	1
31.75767	13.14212	waterbuck	2
31.97000	13.02322	wildebeest	40
31.72307	13.43300	zebra	1
31.64617	13.47074	zebra	2
31.67717	13.25473	zebra	3
32.13717	13.09522	zebra	18