COUNTRYWIDE SURVEY OF ELEPHANTS IN NAMIBIA

DRAFT REPORT

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For: Ministry of Environment and Tourism

December 2011

COUNTRYWIDE SURVEY OF ELEPHANTS IN NAMIBIA: DRAFT REPORT

INTRODUCTION

The objective of this survey was to obtain a national estimate for elephants in Namibia. Fieldwork took place between 29 July and 11 August 2011 (Etosha and Tsumkwe), 6 to 10 September 2011 (Caprivi) and 19 to 25 November 2011 (Northwest Namibia). Areas covered are shown in Figs 1-3. The survey was a sample count at a variety of sampling intensities, depending on assumed elephant densities, in order to obtain a reasonably precise estimate with minimal effort. NW Namibia was a block-sample count flown by helicopter (with some areas of known high occupancy being total-counted). Other areas were transect counts using fixed-wing aircraft.

The aim of this draft report is to present the results of the survey and provide a framework for MET to prepare its own report for wider circulation. Much of the content is therefore left open.

The body of the report summarises the results of the survey. Details of methods are given in Appendix I. Appendix II presents supporting data as a basis for evaluating the survey quality. Appendix III presents the full results for each survey stratum.

In addition to this report a full description of sampling units (block and transect positions and sizes) as a basis for survey planning and aircrew briefings have been provided as an annex. Data in digital format and original data sheets are held by MET.

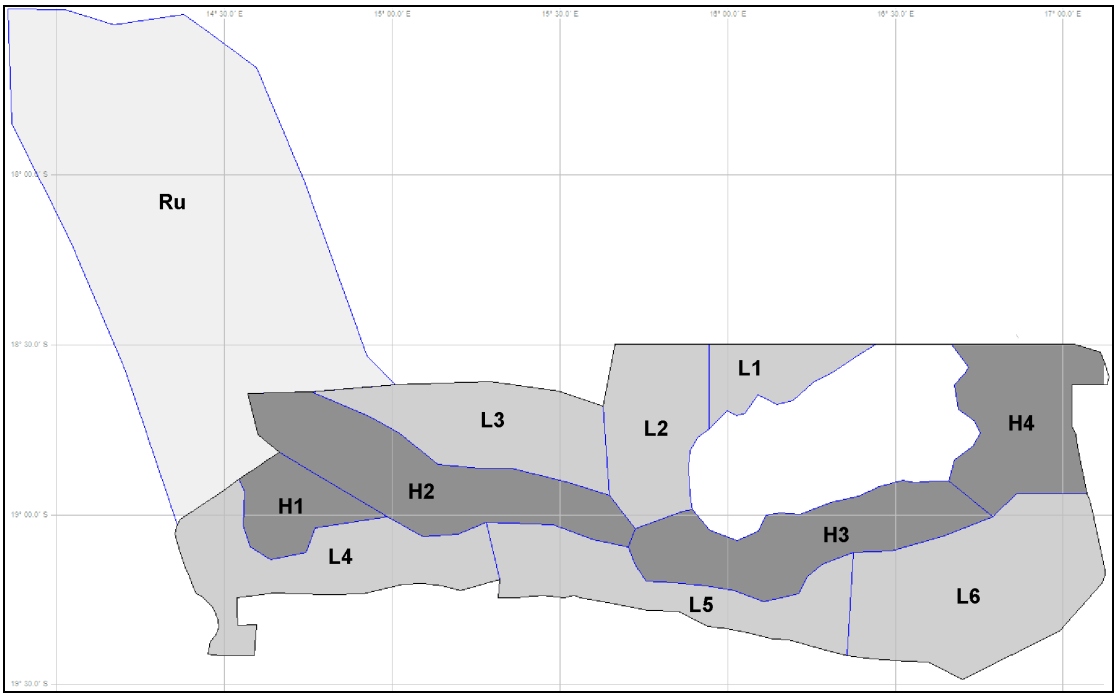

Figure 1: Survey strata in Etosha. Low sampling intensity lighter shading.

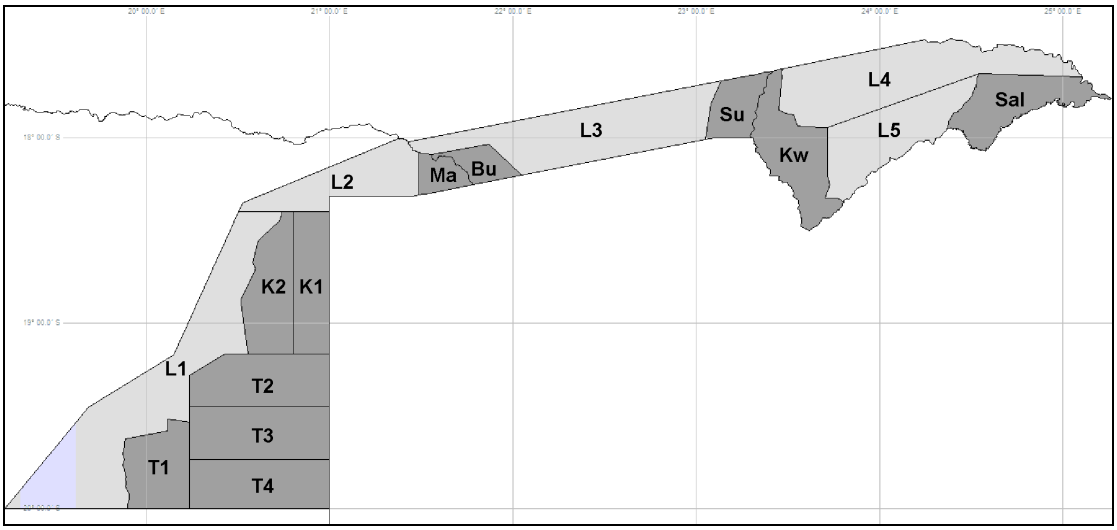

Figure 2: Survey strata in NE Namibia

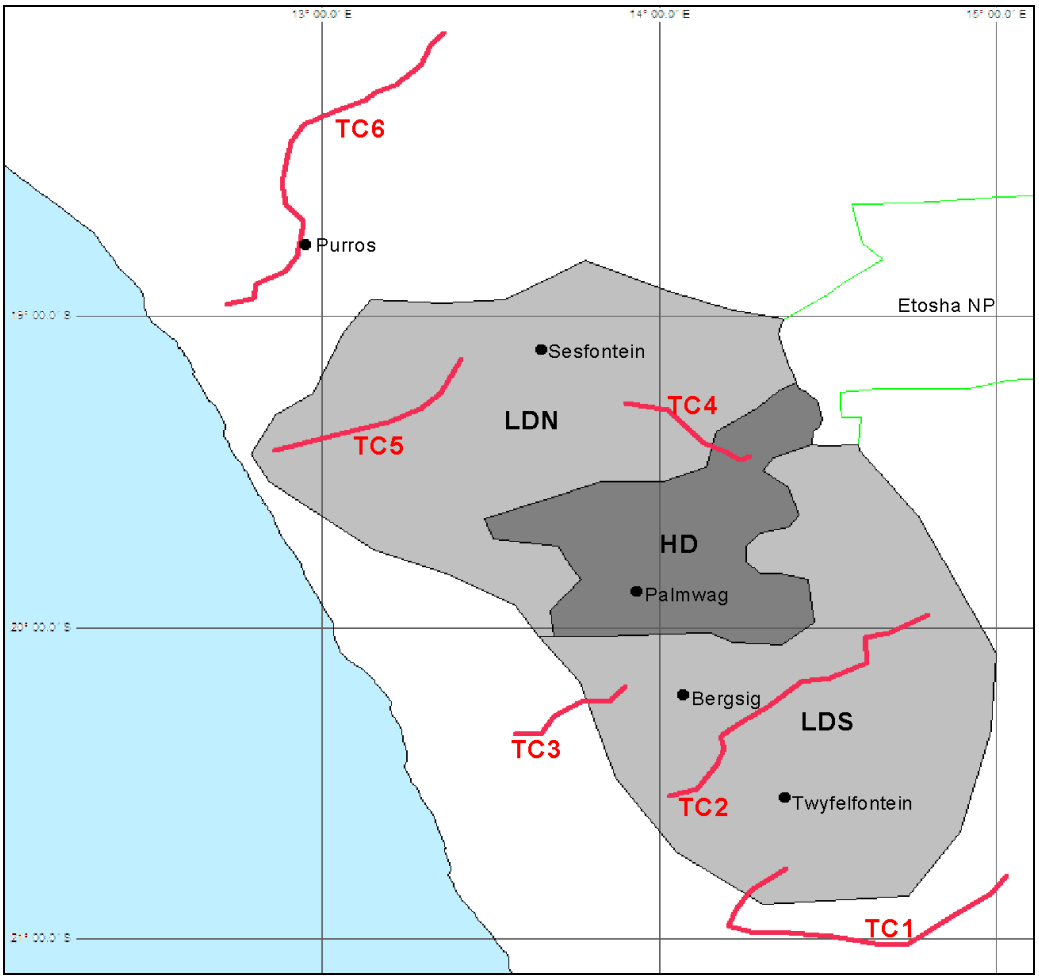

Figure 3: NW Survey Strata. Total count routes in red.

RESULTS

In the following tables the rounded estimates for each stratum are given. The number seen is the number within the sample. The range is that within which the true number is likely to be, with 95% probability.

NATIONAL ESTIMATES

Elephants

Region	Estimate	No seen	Range		
Etosha	3378	609	1622	<>	5134
North East	16833	3140	12109	<>	21559
North West	314	133	221	<>	529
Total	20525	3882	15481	<>	25571

Elephant bulls

Region	Estimate	No seen	Range		
Etosha	394	97	260	<>	528
North East	1554	198	1009	<>	2099
North West	57	17	24	<>	133
Total	2005	312	1439	<>	2571

Elephant in family groups

Region	Estimate	No seen	Range		
Etosha	2984	512	1233	<>	4735
North East	15279	2942	10586	<>	19972
North West	257	116	197	<>	453
Total	18520	3570	13507	<>	23533

Elephant carcasses

Region	Estimate	No seen	Range		
Etosha	78	23	48	<>	109
North East	355	36	135	<>	575
North West	44	4	4	<>	117
Total	477	63	243	<>	711

Overall carcass ratio 2.3%

REGIONAL ESTIMATES: ETOSHA

Elephants

Stratum	Estimate	No seen	Range		
H1	218	51	56	<>	455
H2	87	20	52	<>	157
H3	320	98	169	<>	514
H4	872	334	652	<>	1170
L1*	899	30	30	<>	3264
L2	149	23	23	<>	378
L3	404	18	18	<>	1293
L4	44	2	2	<>	131
L5	167	8	8	<>	452
L6	218	25	60	<>	446
Total	3378	589	1622	<>	5134

Elephant bulls

Stratum	Estimate	No seen	Range		
H1	17	4	4	<>	42
H2	74	17	17	<>	140
H3	85	26	34	<>	136
H4	110	42	72	<>	147
L4	44	2	2	<>	131
L5	21	1	1	<>	66
L6	44	5	5	<>	87
Total	394	97	260	<>	528

Elephants in family groups

Stratum	Estimate	No seen	Range		
H1	201	47	47	<>	451
H2	13	3	3	<>	36
H3	235	72	72	<>	423
H4	762	292	464	<>	1061
L1	899	30	30	<>	3264
L2	149	23	23	<>	378
L3	404	18	18	<>	1293
L5	146	7	7	<>	457
L6	174	20	20	<>	409
Total	2984	512	1234	<>	4735

Carcasses

Stratum	Stage	Estimate	No seen	Range
H2	Elephant carcass 3	4	1	1 <> 12
H2	Elephant carcass 4	9	2	2 <> 19
H3	Elephant carcass 3	3	1	1 <> 9
H3	Elephant carcass 4	13	4	4 <> 24
H4	Elephant carcass 2	3	1	1 <> 7
H4	Elephant carcass 3	5	2	2 <> 11
H4	Elephant carcass 4	26	10	12 <> 40
L2	Elephant carcass 4	6	1	1 <> 19
L6	Elephant carcass 4	9	1	1 <> 26
	Total	78	23	48 <> 109

Carcass ratio = 2.3 %

* Stratum L1's estimate is based on a single sighting within the sample.
No elephants were seen in the Ruacana stratum, though they are known to be present.

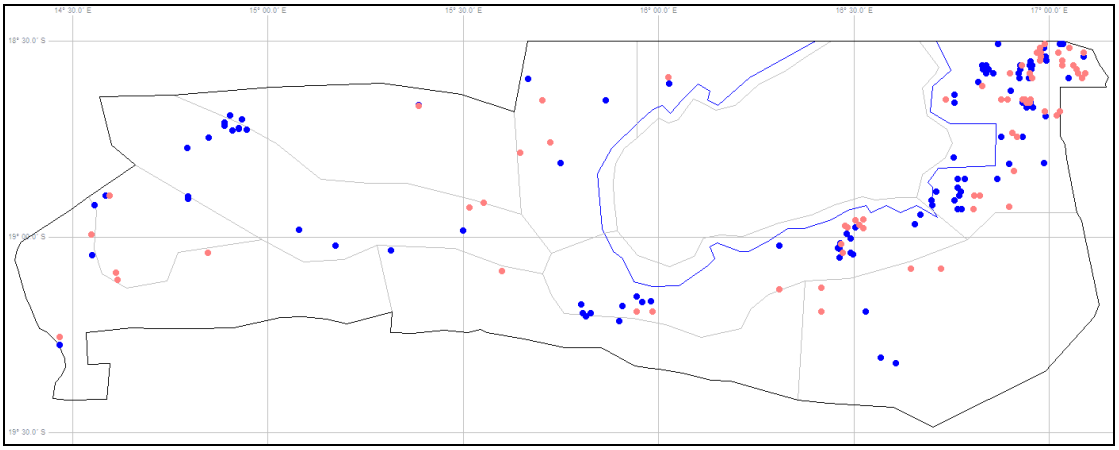

Figure 4: Elephant sightings in Etosha. Blue: bulls; Pink: family groups

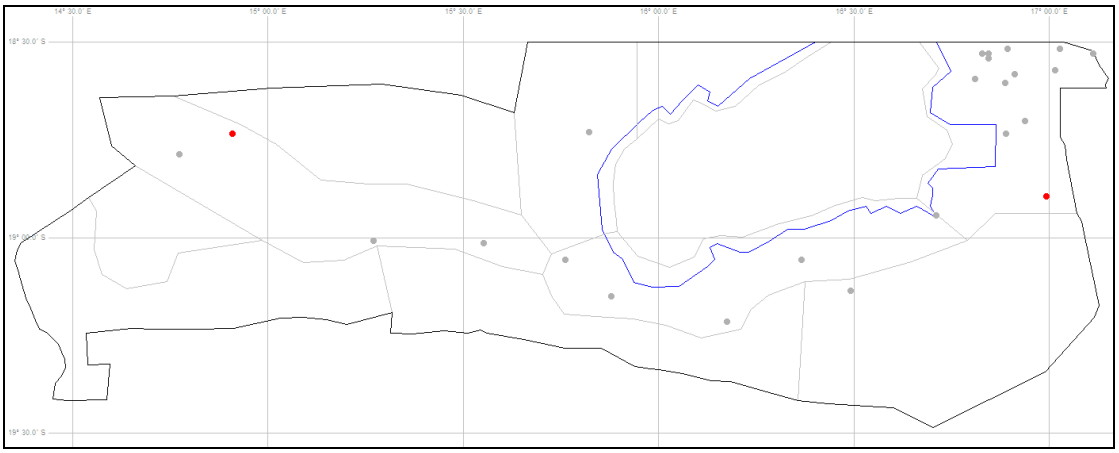

Figure 5: Carcass sightings in Etosha. Red: fresh-recent; Grey: old-very old

REGIONAL ESTIMATES: NORTH EAST

Elephants

Stratum	Estimate	No seen	Range		
Khaudum1	1133	242	434	<>	2049
Khaudum2	1623	338	764	<>	2482
Tsumkwe2	1090	38	44	<>	2256
Tsumkwe3	767	27	50	<>	1692
Tsumkwe4	118	4	7	<>	340
NE L1*	1256	30	58	<>	4155
NE L3	440	10	10	<>	1053
NE L5	1776	41	51	<>	4700
Mahango	132	28	52	<>	234
Buffalo	1328	267	706	<>	2005
Susuwe	2411	979	2048	<>	3038
Kwando	3770	1022	2304	<>	5237
Salambala	990	114	201	<>	2068
Total	16834	3140	12159	<>	21611

Elephant bulls

Stratum	Estimate	No seen	Range		
Khaudum1	80	17	43	<>	142
Khaudum2	110	23	43	<>	189
Tsumkwe2	172	6	12	<>	604
Tsumkwe3	313	11	28	<>	616
Tsumkwe4	118	4	7	<>	340
NE L3	176	4	4	<>	457
NE L5	87	2	5	<>	303
Mahango	94	20	44	<>	177
Buffalo	99	20	42	<>	166
Susuwe	111	45	75	<>	147
Kwando	151	41	95	<>	208
Salambala	43	5	6	<>	103
Total	1554	198	1009	<>	2099

Elephants in family groups

Stratum	Estimate	No seen	Range		
Khaudum1	1053	225	391	<>	1978
Khaudum2	1512	315	647	<>	2378
Tsumkwe2	918	32	32	<>	2353
Tsumkwe3	455	16	22	<>	1604
NE L1	1256	30	58	<>	4155
NE L3	264	6	6	<>	912
NE L5	1690	39	46	<>	5742
Mahango	38	8	8	<>	109
Buffalo	1229	247	664	<>	1971
Susuwe	2300	934	1973	<>	2935
Kwando	3619	981	2155	<>	5083
Salambala	946	109	195	<>	2053
Total	15279	2942	10586	<>	19972

Carcasses

Stratum	Stage	Estimate	No seen	Range		
Khaudum1	Elephant carcass 4	5	1	1	<>	13
Tsumkwe2	Elephant carcass 4	57	2	2	<>	147
NE L3	Elephant carcass 4	44	1	1	<>	141
NE L4	Elephant carcass 3	52	1	1	<>	167
NE L5	Elephant carcass 2	87	2	2	<>	303
Mahango	Elephant carcass 4	5	1	1	<>	14
Buffalo	Elephant carcass 4	5	1	1	<>	15
Susuwe	Elephant carcass 1	2	1	1	<>	6
Susuwe	Elephant carcass 2	5	2	2	<>	10
Susuwe	Elephant carcass 4	10	4	4	<>	17
Kwando	Elephant carcass 1	11	3	3	<>	22
Kwando	Elephant carcass 2	7	2	2	<>	16
Kwando	Elephant carcass 3	7	2	2	<>	16
Kwando	Elephant carcass 4	41	11	11	<>	92
Salambala	Elephant carcass 4	17	2	2	<>	50
	Totals	355	36	135	<>	575

Carcass ratio = 2.06%

* Stratum L1 has a very high estimate, with low precision, based on one sighting adjacent to Khaudum. While one must be cautious about the use of this result at a local level, it is part of the overall sample, valid at the national level.

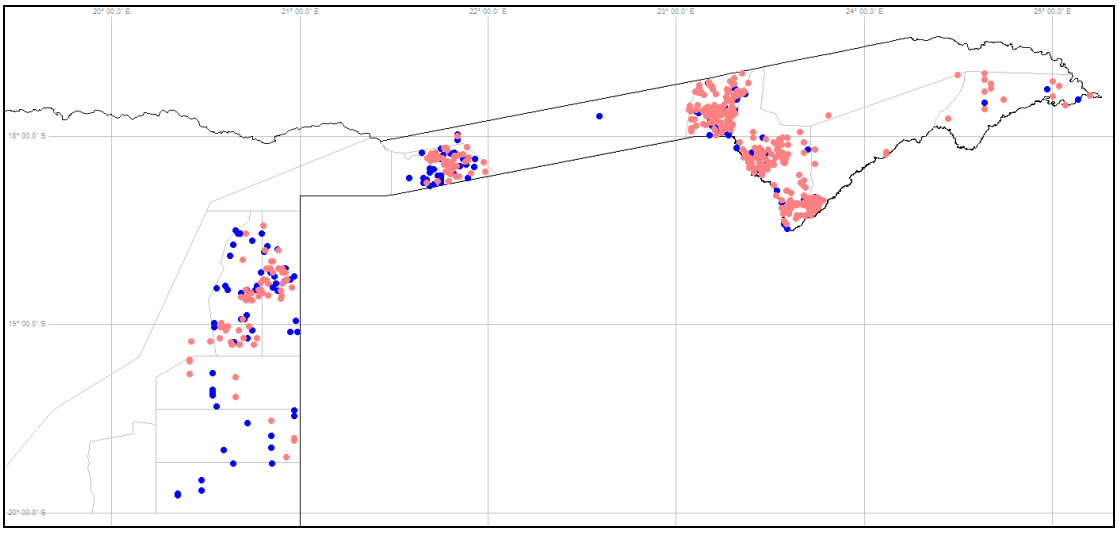

Figure 6: Elephant sightings in north east

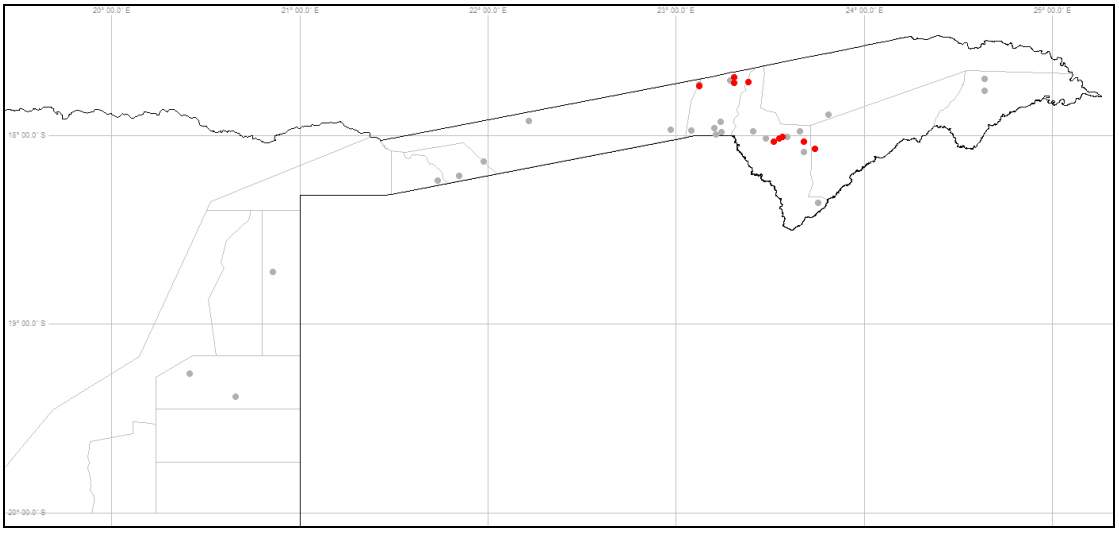

Figure 7: Carcass sightings in north east

REGIONAL ESTIMATES: NORTH WEST

Elephants

Stratum	Estimate	No seen	Range
HD	192	48	98 <> 355
LDN	38	1	2 <> 115
LDS *	0 (37)	0	
TC1	29	29	
TC2	12	12	
TC4	1	1	
TC5	31	31	
TC6	11	11	
Total	314(351)	133	221 <> 529

Elephant bulls

Stratum	Estimate	No seen	Range
HD	4	1	4 <> 11
LDN	38	1	2 <> 115
LDS*	0 (3)	0	
TC1	4	4	
TC2	1	1	
TC4	1	1	
TC5	5	5	
TC6	4	4	
Total	57 (60)	17	24 <> 133

Elephants in family groups

Stratum	Estimate	No seen	Range
HD	188	47	94 <> 352
LDS*	0 (34)	0	
TC1	25	25	
TC2	11	11	
TC5	26	26	
TC6	7	7	
Total	257 (291)	116	197 <> 453

Elephant carcasses

Stratum	Estimate	No seen	Range
LDN (stage 2)	38	1	1 <> 115
TC6 (stage 2)	1	1	
HD (stage 4)	4	1	1 <> 11
TC2 (stage 4)	1	1	
Total	44	4	4 <> 117

Carcass ratio = 12.3%. This is very imprecise

* No elephants sightings were made within the sample in stratum LDS. However 37 elephants were seen outside the sample blocks in the stratum and were therefore present. This is reflected by the numbers in brackets. Stratum LDS contributes zero to the national estimate as this is the estimate in terms of the overall sample.

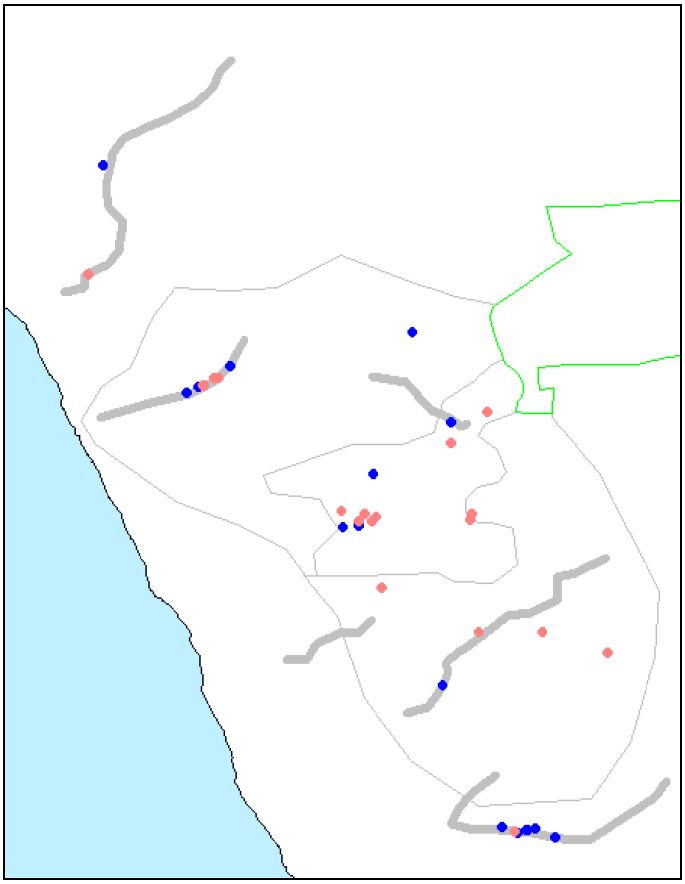

Figure 8: Elephant sightings in NW

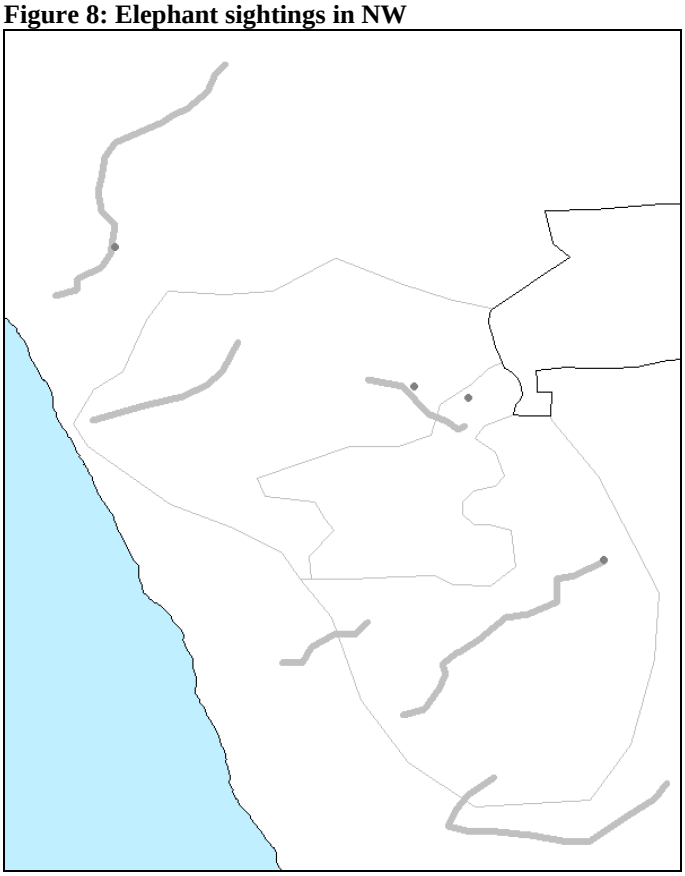

Figure 9: Carcass sightings in NW

DISCUSSION

The national estimate produced, of around 20 000 elephants, is subject to some imprecision (± 5000) i.e. there is a 95% probability hat the true number lies between 15000 and 25000. These limits are a necessary measure of the reliability of the result which render it comparable with results from other such surveys.

The precision of the result will always depend to some extent on the quality of prior information available and how effectively it is put to use in the survey design. This is especially true here, where elephant populations range over extensive areas and are seldom constrained by hard boundaries. Precision can be improved in future by correction of the following planning errors:

> Misplacement of stratum boundaries in relation to elephant concentrations: This can be avoided in future, to some extent, by extending medium or high intensity sampling into areas where elephants have been found close to areas of high densities. Among others, this should be done on the east of stratum L2 in Etosha, on the western boundary of Khaudum, the Botswana border along the Linyanti river and to the south of stratum HD in the north west. In addition, sampling was extended too far west, into arid areas with no elephants in the north west; effort here would have been better spent elsewhere.
>
> Misallocation of sampling intensity: Tsumkwe (strata T1, T2 and T4) has more elephants than anticipated; more effort should have been applied here. In Kwando elephants were largely absent from the conservancies; this stratum should have been split into conservancies surveyed at medium sampling effort and reserves at high effort. In the North West sampling was too low in parts. This is partly because a fixed-wing aircraft was not available for the North West so that the available helicopter time had to be spread over a wider area and at a lower sampling intensity than planned.

Lack of precision does not imply bias. The estimate may not correctly reflect the true number of elephants, but the confidence interval indicates the range within which the true number lies. Bias results from the observers missing or over-counting animals and when areas within the country with elephants are excluded from the survey. While parts of the range were missed, the number of elephants involved is believed to be negligible in comparison to the overall estimate and its confidence limits. Minimising observer bias depends on having observers with sufficient experience and competence, a requirement which was met in this case. The observers task is facilitated by having a narrow strip to search and by a slow ground speed, giving time to search and count. The target search rate was 1 square kilometre per minute. This was not achieved over much of the area, although the actual rates of around 1.5 are considered adequate for elephants. This is probably not true for carcasses, a proportion of which are probably missed under the best of conditions, so the carcass ratios may be something of an underestimate. These were well within what is considered sustainable by a safe margin, however: the only high ratios occur where the sample was very small. Nevertheless, the occurrence of fresh carcasses near the Angolan border suggests some illegal killing is taking place.

APPENDIX I: METHODS

The survey used standard methods of sampling employed by MET in past surveys, i.e. transect sampling using fixed wing aircraft and block sampling using a helicopter. Transects were evenly spaced from a random starting point. Figs 10-11 show the placement. Blocks in the high intensity sample area (Fig. 12) were evenly spaced on a 2' grid to provide the best distribution information and facilitate navigation between blocks. Blocks were considered in the stratum if the centre point fell within the boundary vector. In the low intensity strata, blocks were placed by randomly selecting squares from the grid without replacement. This eliminates edge effect bias and minimises commuting time, as the most convenient route among blocks can be selected.

Streamers were used as strip markers for the transect counts, while the GPS was used to determine whether sightings were in the sample during the block counts.

Routes were navigated using GPS and all routes actually flown and sightings made were recorded on GPS and downloaded to computer after each flight.

All elephants seen by the observers were counted and recorded by the front seat observer who also recorded the position of each sighting on the GPS. Whether the sightings were inside or outside the sample (in or out of block or transect) was also recorded. Elephants were recorded as bulls or elephants in family groups. Carcasses were recorded as carcass 1(fresh), carcass 2(recent), carcass 3(old) or carcass 4(very old).

Analysis was by Jolly's method for unequal sized sampling units.

Two fixed-wing aircraft (Cessna 182s GCV and ISE) were used from 27 July to 11 August. Only ISE was available after that date and it was recalibrated for the continuation of the survey from 6 – 10 September. It was also intended to use a fixed wing to survey flat terrain in the North West. However no fixed wing was available for this so the hours allocated for helicopter flying had to be used to cover as much of the area as possible.

Crews were:
GCV: Pilot-F Henning; front observer-C Craig; left observer – J Kapner; right observer – D Chipesi.
ISE 27/6/11 – 11/8/11: Pilot – N Brain; front: D Mughogho; left – G Shatumbu; right - N Chitemamuswe.
ISE 6/9/11-10/9/11: Pilot – N Brain; front: C Craig; left – J Kapner; right - G Shatumbu.
HER: Pilot – D Eberlein; front: C Craig; left – J Kapner; right – W Kilian.

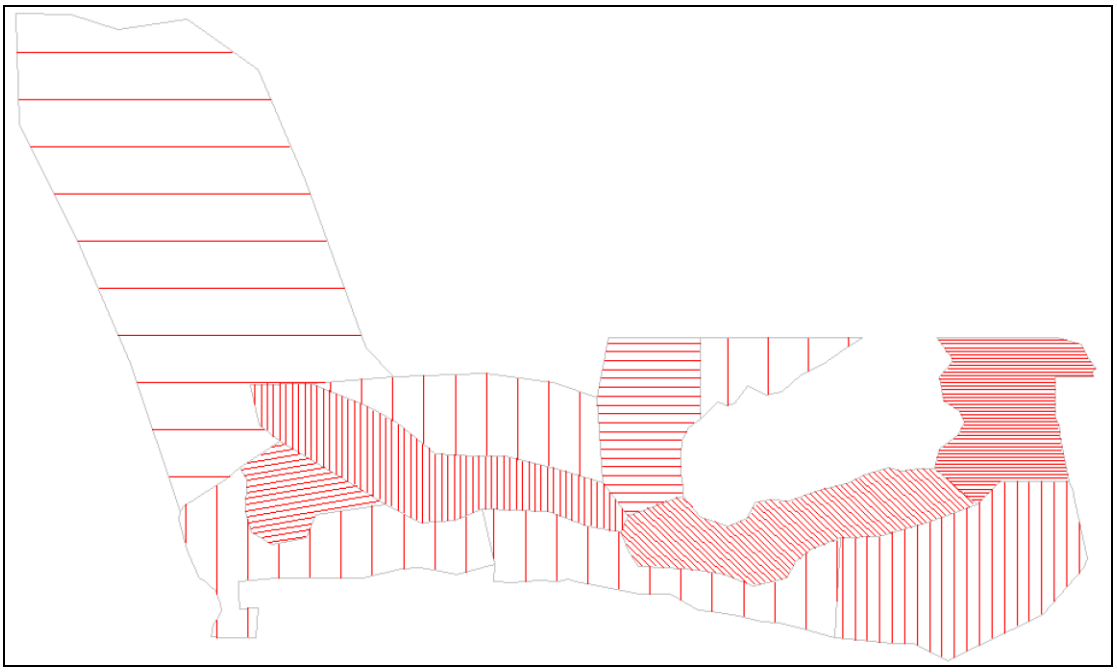

Figure 10: Etosha Sampling Units

Figure 11: NE Sampling units

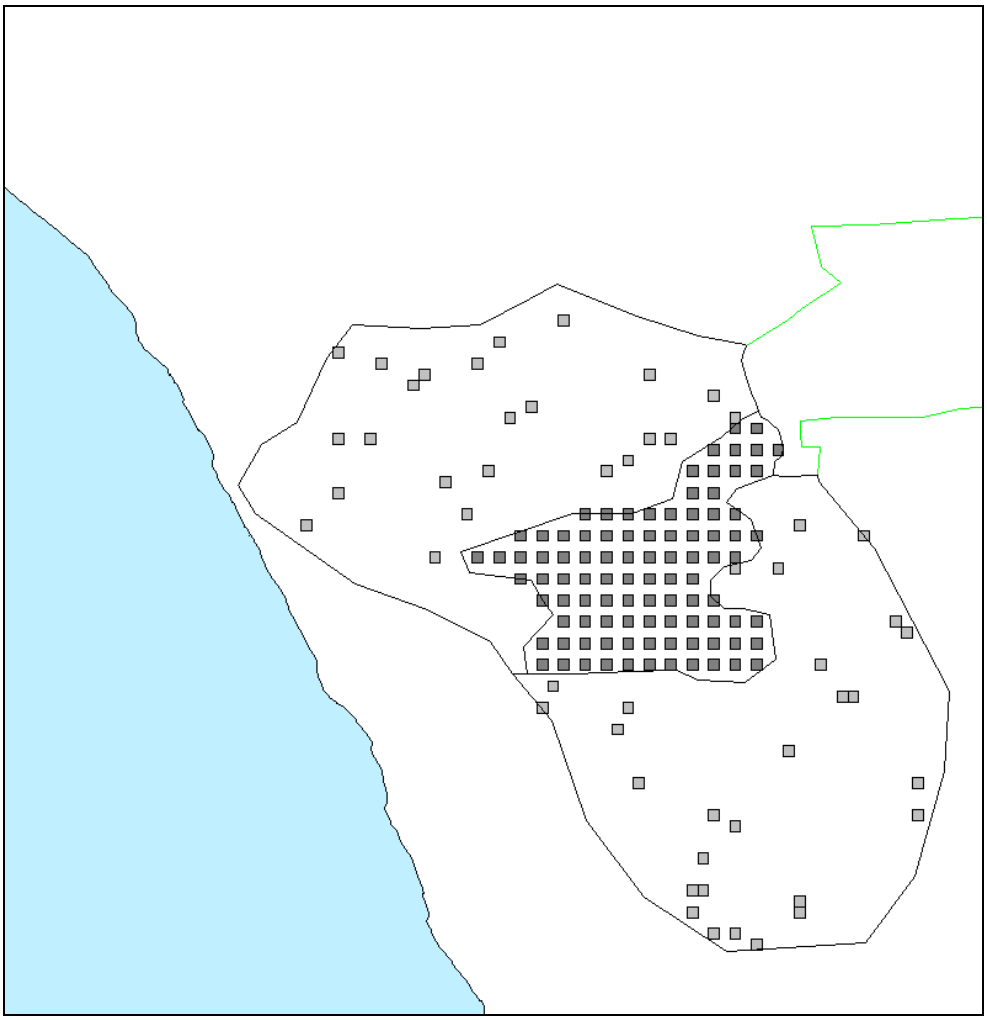

Figure 12: Sampling units in NW sample counts

APPENDIX II: SURVEY EXECUTION

Calibration: GCV 27/7/2011 – 11/8/2011

H	L In	L out	R in	R out	Width L	Width R	Corrected L	R	Tot W
295	7	26	8	26	200	190	203.3898	193.2203	396.6102
290	7	29	6	24	230	190	237.931	196.5517	434.4828
250	8	26	7	22	190	160	228	192	420
285	7	28	9	29	220	210	231.5789	221.0526	452.6316
250	7	29	6	25	230	200	276	240	516
270	7	29	5	22	230	180	255.5556	200	455.5556
280	8	28	6	26	210	210	225	225	450
295	7	27	7	28	210	220	213.5593	223.7288	437.2881
190	4	19	5	20	160	160	252.6316	252.6316	505.2632
245	6	23	5	24	180	200	220.4082	244.898	465.3061
300	6	25	9	28	200	200	200	200	400
290	8	29	8	28	220	210	227.5862	217.2414	444.8276
305	6	26	10	30	210	210	206.5574	206.5574	413.1148
290	7	26	6	28	200	230	206.8966	237.931	444.8276
300	4	24	10	29	210	200	210	200	410
285	7	28	5	24	220	200	231.5789	210.5263	442.1053
250	5	25	5	24	210	200	252	240	492
250	5	23	4	25	190	220	228	264	492
240	4	22	5	25	190	210	237.5	262.5	500
235	5	26	4	22	220	190	280.8511	242.5532	523.4043
270	6	28	5	27	230	230	255.5556	255.5556	511.1111
250	7	28	4	22	220	190	264	228	492
230	5	25	3	21	210	190	273.913	247.8261	521.7391
300	7	28	5	26	220	220	220	220	440
								Mn	460.8445
								Var	1597.83
								SE Mn	9.170404
								%CL	3.979826

Observers: Left – G Shatumbu; Right – N Chitemamuswe

Calibration: ISE 27/7/2011 – 11/8/2011

H	L In	L out	R in	R out	Width L	Width R	Corrected L	Corrected R	Tot W
250	9	25	8	20	170	130	204	156	360
240	10	28	5	20	190	160	237.5	200	437.5
235	9	28	9	24	200	160	255.3191	204.2553	459.5745
230	7	22	9	25	160	170	208.6957	221.7391	430.4348
250	9	27	10	29	190	200	228	240	468
240	8	21	9	27	140	190	175	237.5	412.5
250	10	27	9	27	180	190	216	228	444
245	11	25	9	27	150	190	183.6735	232.6531	416.3265
255	13	29	9	28	170	200	200	235.2941	435.2941
240	9	24	9	27	160	190	200	237.5	437.5
230	9	22	9	28	140	200	182.6087	260.8696	443.4783
250	9	27	10	27	190	180	228	216	444
250	9	24	10	28	160	190	192	228	420
250	10	29	10	28	200	190	240	228	468
250	11	27	10	29	170	200	204	240	444
240	11	28	9	27	180	190	225	237.5	462.5
240	11	27	8	26	170	190	212.5	237.5	450
250	13	29	8	26	170	190	204	228	432
250	11	27	9	27	170	190	204	228	432
240	8	26	10	28	190	190	237.5	237.5	475
250	8	28	9	27	210	190	252	228	480
								Mn	444.6054
								Var	367.8492
								SE Mn	4.400055
								%CL	1.979308

Observers: Left – J Kapner; Right – D Chipesi

Calibration ISE 6/9/2011 – 10/9/2011

H	L In	L out	R in	R out	Width L	Width R	Corrected L	Corrected R	Tot W
300	12	29	6	29	180	240	180	240	420
300	11	29	6	25	190	200	190	200	390
295	12	30	9	27	190	190	193.2203	193.2203	386.4407
245	11	28	6	23	180	180	220.4082	220.4082	440.8163
245	11	26	5	25	160	210	195.9184	257.1429	453.0612
250	9	22	8	25	140	180	168	216	384
250	8	22	8	26	150	190	180	228	408
250	9	25	7	24	170	180	204	216	420
245	11	23	5	22	130	180	159.1837	220.4082	379.5918
240	14	27	3	20	140	180	175	225	400
235	16	27	0	17	120	180	153.1915	229.7872	382.9787
250	13	27	5	21	150	170	180	204	384
240	16	28	5	17	130	130	162.5	162.5	325
220	13	27	0	12	150	130	204.5455	177.2727	381.8182
250	10	27	7	23	180	170	216	204	420
250	8	26	8	28	190	210	228	252	480
245	8	21	9	23	140	150	171.4286	183.6735	355.102
250	8	22	7	27	150	210	180	252	432
240	8	19	9	28	120	200	150	250	400
								Mn	402.2531
								Var	1252.583
								SE Mn	8.119446
								%CL	4.036984

Observers: Left – J Kapner; Right – G Shatumbu

Routes flown

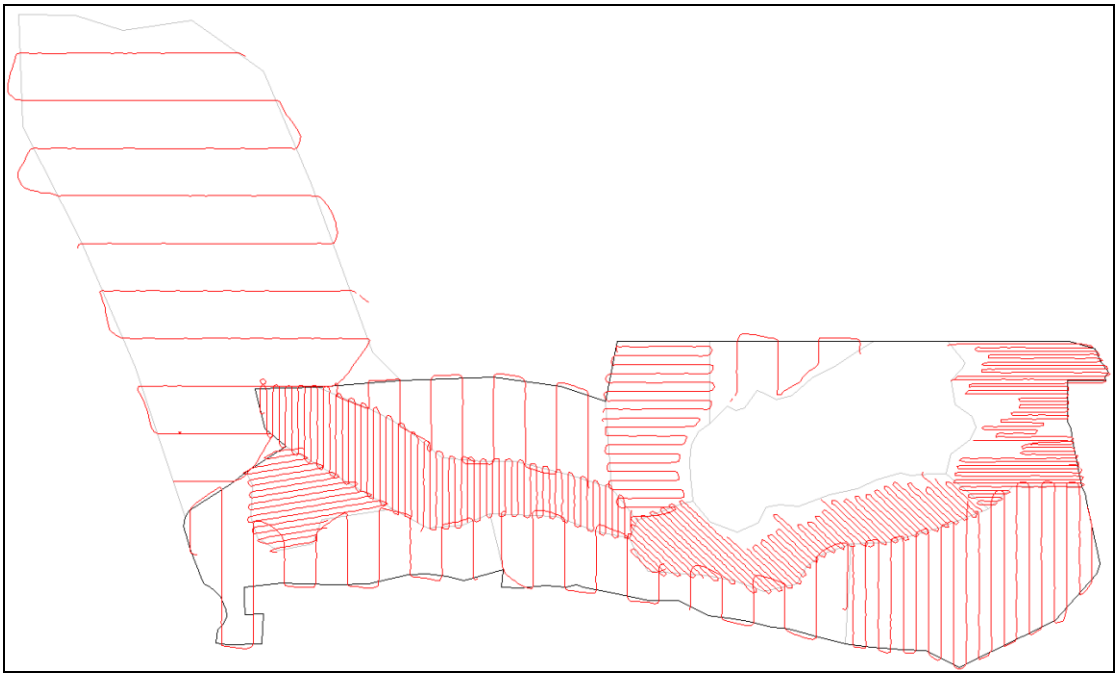

Figure 13: Tracks Flown in Etosha

Figure 14: Tracks Flown in N0rth East

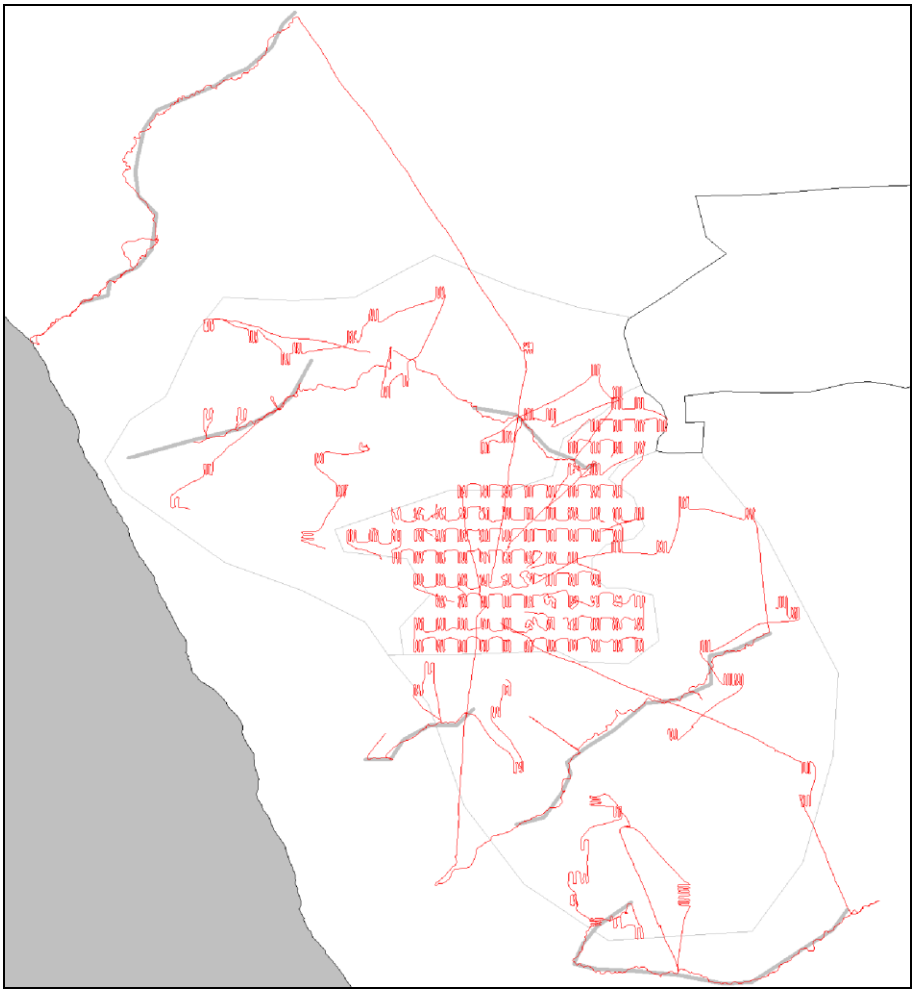

Figure 15: Tracks flown in North West

Attributes of strata and survey performance

Etosha/Tsumkwe

Stratum	Date	Area	No Su s	Spacing	SI%	Mn GS Km/h	Tot SR
Etosha H1	29-Jul-11	843	17	2	23.66	175.49	1.38
Etosha H2	29-Jul-11	2504.8	60	2	23.85	224.76	1.78
Etosha H3	31-Jul-11	2171	62	1.5	31.49	211.42	1.66
Etosha H4	30-Jul-11	1933.8	46	1.2	39.31	200.47	1.59
Etosha L1	01-Aug-11	773.3	4	13	3.38	166.22	1.27
Etosha L2	27-Jul-11	1625.5	20	3	16.1	191.04	1.54
Etosha L3	28-Jul-11	1946.6	9	10	4.82	173.53	1.42
Etosha L4	31-Jul-11	2253.5	1	10	4.57	168.12	1.34
Etosha L5	31-Jul-11	2002.5	12	10	4.9	169.09	1.33
Etosha L6	01-Aug-11	3302.2	20	4	11.77	185.48	1.44
Ruacana	02-Aug-11	10838	10	16	2.87	189.84	1.50
Khaudum1	08-Aug-11	1792.2	39	2.2	21.62	173.79	1.37
Khaudum2	08-Aug-11	1955	39	2.2	21.59	197.92	1.57
Tsumkwe1	09-Aug-11	1713.1	4	13	3.33	210.22	1.67
Tsumkwe2	09-Aug-11	2396.8	6	13	3.53	184.94	1.49
Tsumkwe3	09-Aug-11	2509.9	6	13	3.56	182.62	1.47
Tsumkwe4	07-Aug-11	2368.7	6	13	3.51	186.95	1.46
NE L1	09-Aug-11	6665.3	9	20	2.48	195.99	1.54
NE L2	11-Aug-11	2181.4	6	20	2.52	210.66	1.66
NE L3	11-Aug-11	4436.7	9	20	2.3	183.19	1.40
Overall	29/7-11/8					194.31	1.53

Caprivi

Stratum	Date	Area	No Su s	Spacing	SI%	Mn GS Km/h	Tot SR
NE L4	09-Sep-11	4482.6	8	20	1.92	225.13	1.51
NE L5	08-Sep-11	2724.2	5	20	2.31	193.34	1.31
Buffalo	10-Sep-11	602.7	10	2	21.26	181.62	1.22
Mahango	10-Sep-11	533.2	16	2	20.1	233.54	1.57
Susuwe	06-Sep-11	982.9	36	1	40.6	187.19	1.27
Kwando	07-Sep-11	2243.2	64	1.5	27.11	195.95	1.33
Salambala	09-Sep-11	1953.1	27	3.5	11.52	194.79	1.31
Overall	9/9-11/9					195.46	1.32

North West (Aircraft: helicopter HER)

Stratum	Date	Area	No Su s	Sample Area	SI%	Total Time(min)	Tot SR
HD	19/11-21/11	4895.7	95	1224.3	25.01	1094	1.12
LDN	22/11-23/11	11711.6	24	310.2	2.65	220	1.41
LDS	23/11-25/11	12995.1	28	359.5	2.77	249	1.44
TC1	24-Nov-11	82.3	-	82.3	100	84	0.98
TC2	25-Nov-11	106.1	-	106.1	100	82	1.28
TC3	23-Nov-11	27.8	-	27.8	100	17	1.56
TC4	22-Nov-11	51	-	51	100	40	1.27
TC5	22-Nov-11	49.2	-	49.2	100	43	1.12
TC6	23-Nov-11	130.7	-	130.7	100	124	1.05
Overall	19/11-25/11		-		7.79		1.2

SU = sampling unit; SI = sampling intensity; GS = groundspeed in km/hr; SR = search rate in km^2/min

The above data is grouped in the 3 separate periods when surveys took place. The following show the performances by individual fixed-wing aircraft.

Search rates by fixed-wing aircraft

Aircraft	Dates	Time (mins)	Distance on transects	Area sampled	Ground - speed	Search rate
CGV	29/7-11/8	1453	4323	2041.26	178.51	1.4
ISE	29/7-11/8	1584	5562.52	2636.92	210.7	1.66
ISE	6/9-10/9	1204	3922.2	1591.74	195.46	1.32
Total		4241	13807.72	6269.92	195.35	1.48

Heights flown by fixed-wing aircraft

Dates	Aircraft	Mean height	Standard deviation
29/7-11/8	CGV	303.4455	15.32399
29/7-11/8	ISE	307.6068	23.05745
6/9-10/9	ISE	302.6077	8.792217

APPENDIX III: RESULTS BY STRATUM

These are the individual stratum results which have been combined to give higher level results reported above. No. out is the number seen outside of the sampling units. Where the calculated lower limit of the confidence range is less than the number actually seen in the stratum (including all sightings, both in and out), the number seen is given as the lower limit of the range.

ETOSHA

Stratum H1

Area: 843 Km² Sampling intensity: 23.38 %

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	17	4	5	140.4569	146.82	9	<>	42.23	0.020
Elephant in family group	201	47	20	13873.99	124.19	67	<>	450.75	0.238

Stratum H2

Area: 2504.8 Km² Sampling intensity:23.09%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	74	17	15	1114.039	90.71	32	<>	140.41	0.029
Elephant in family group	13	3	17	131.1912	176.40	20	<>	35.91	0.005
Elephant carcass 3	4	1		14.24218	174.36	1	<>	11.88	0.002
Elephant carcass 4	9	2	1	28.4264	123.17	3	<>	19.33	0.003

Stratum H3
Area: 2171 Km² Sampling intensity: 30.61%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	85	26	11	646.9012	59.87	37	<>	135.81	0.039
Elephant in family group	235	72	60	8788.299	79.69	132	<>	422.69	0.108
Elephant carcass 3	3	1		7.361701	166.06	1	<>	8.69	0.002
Elephant carcass 4	13	4		28.60185	81.83	4	<>	23.76	0.006

Stratum H4

Area: 1933.8 Km² Sampling intensity: 38.31%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. Out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	110	42	46	342.3506	33.99	88	<>	146.91	0.057
Elephant in family group	762	292	272	21922.4	39.12	564	<>	1060.50	0.394
Elephant carcass 2	3	1		4.17144	157.58	1	<>	6.72	0.001
Elephant carcass 3	5	2		8.012081	109.19	2	<>	10.92	0.003
Elephant carcass 4	26	10		47.5364	53.19	12	<>	39.99	0.013

Stratum Et L1

Area: 773.3 Km² Sampling intensity: 3.34%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull			1				
Elephant in family group	899	30		552164.5	262.94	30 <> 3264.12	1.163

Stratum Et L2

Area: 1625.5 Km² Sampling intensity: 15.40%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull			3				
Elephant in family group	149	23	3	11950.82	153.23	23 <> 378.13	0.092
Elephant carcass 4	6	1		34.7204	189.96	1 <> 18.83	0.004

Stratum Et L3

Area: 1946.6 Km² Sampling intensity: 4.46%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull			1				
Elephant in family group	404	18		148618.3	220.18	18 <> 1292.73	0.207

Stratum Et L4

Area: 2253.5 Km² Sampling intensity: 4.52%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	44	2		1556.448	196.26	2 <> 131.08	0.020
Elephant in family group			20				

Stratum Et L5

Area: 2002.5 Km² Sampling intensity: 4.79%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	21	1		417.8816	215.67	1 <> 65.86	0.010
Elephant in family group	146	7		19922.58	212.73	7 <> 456.70	0.073

Stratum Et L6

Area: 3302.1 Km² Sampling intensity: 11.48%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	44	5		425.5486	99.16	5	<>	86.72	0.013
Elephant in family group	174	20	35	12550.59	134.62	55	<>	408.65	0.053
Elephant carcass 4	9	1		68.30183	198.63	1	<>	26.01	0.003

Stratum Ruacana

Area: 10838.4 Km² Sampling intensity: 2.87%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
		Nil					

NORTH EAST

Stratum Khaudum1

Area: 1792.2 Km² Sampling intensity: 21.36%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. Out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	80	17	26	945.9887	78.25	43	<>	141.84	0.044
Elephant in family group	1053	225	166	208751.1	87.82	391	<>	1978.12	0.588
Elephant carcass 4	5	1		17.23671	179.56	1	<>	13.09	0.003

Stratum Khaudum 2

Area: 1955 Km² Sampling intensity: 20.83%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. Out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	110	23	20	1489.736	70.76	43	<>	188.56	0.056
Elephant in family group	1512	315	218	182897.2	57.25	647	<>	2378.08	0.774

Stratum Tsumkwe1

Area: 1713.1 Km² Sampling intensity: 3.21%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
		Nil					

Stratum Tsumkwe2

Area: 2396.8 Km² Sampling intensity: 3.49%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. Out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	172	6	6	28287.29	251.31	12	<>	604.38	0.072
Elephant in family group	918	32		311733.8	156.43	32	<>	2352.76	0.383
Elephant carcass 4	57	2		1217.71	156.43	2	<>	147.05	0.024

Stratum Tsumkwe3

Area: 2509.9 Km² Sampling intensity:3.52%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. Out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	313	11	17	13925.21	97.04	28	<>	615.94	0.125
Elephant in family group	455	16	6	199849.4	252.74	22	<>	1603.85	0.181

Stratum Tsumkwe4

Area: 2368.7 Km² Sampling intensity: 3.39%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	118	4	3	7426.503	187.64	7 <> 339.59	0.050
Elephant in family group			6				

Stratum NE L1

Area: 6665.3 Km² Sampling intensity: 2.39%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull			1				
Elephant in family group	1256	30	28	1581016	230.92	58 <> 4155.15	0.188

Stratum NE L2

Area: 2181.4 Km² Sampling intensity: 2.43%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
		Nil					

Stratum NE L3

Area: 4436.7 Km² Sampling intensity: 2.27%

ESTIMATES:

SPECIES	Pop. est.	No. Seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	176	4		14811.81	159.47	4 <> 456.64	0.04
Elephant in family group	264	6		79077.64	245.65	6 <> 912.45	0.059
Elephant	440	10		93889.45		10 <> 1052.8	0.1
Elephant carcass 4	44	1		1768.714	220.43	1 <> 140.98	0.01
Elephant carcass 3			1				

Stratum NE L4

Area: 4482.6 Km² Sampling intensity:1.92%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant in family group			30				
Elephant carcass 3	52	1	1	2359.516	221.1	2 <> 166.8	0.012

Stratum NE L5

Area: 2724.2 Km² Sampling intensity: 2.31%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	87	2	3	6086.074	250	5	<>	303.2	0.032
Elephant in family group	1690	39	17	2130819	239.9	46	<>	5742.4	0.620
Elephant carcass 2	87	2		6086.074	250	2	<>	303.2	0.032

Stratum Mahango

Area: 533.2 Km² Sampling intensity: 21.26%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	94	20	24	1512.365	88.1	44	<>	176.9	0.176
Elephant in family group	38	8		1123.167	189.9	8	<>	109.1	0.071
Elephant carcass 4	5	1		18.54398	195.2	1	<>	13.9	0.009

Stratum Buffalo

Area: 602.7 Km² Sampling intensity: 20.10%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	99	20	22	900.3086	66.4	42	<>	165.5	0.165
Elephant in family group	1229	247	417	113722.7	60.4	664	<>	1970.9	2.039
Elephant carcass 4	5	1	1	19.47389	195.3	2	<>	14.7	0.008

Stratum Susuwe

Area: 982.9 Km² Sampling intensity: 40.61%

ESTIMATES:

SPECIES	Pop. est.	No. Seen	No. out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	111	45	26	318.9014	32.7	75	<>	147.1	0.113
Elephant in family group	2300	934	1039	97830.5	27.6	1973	<>	2935.2	2.340
Elephant carcass 1	2	1	1	3.592648	156.2	2	<>	6.3	0.003
Elephant carcass 2	5	2		6.933855	108.5	2	<>	10.3	0.005
Elephant carcass 4	10	4	3	14.02492	77.2	7	<>	17.5	0.010

Stratum Kwando

Area: 2243.2 Km² Sampling intensity: 27.11%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	151	41	12	803.4777	37.5	94.6	<>	207.9	0.067
Elephant in family group	3619	981	959	536939.3	40.5	2155	<>	5083.2	1.613
Elephant carcass 1	11	3		28.23992	96	3	<>	21.7	0.005
Elephant carcass 2	7	2		18.68225	117.1	2	<>	16	0.003
Elephant carcass 3	7	2		18.64145	116.9	2	<>	16	0.003
Elephant carcass 4	41	11		650.5298	125.6	11	<>	91.5	0.018

Stratum Salambala

Area: 1953.1 Km² Sampling intensity: 11.52%

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range			Dens /Km²
Elephant bull	43	5	1	827.0238	136.2	6	<>	102.5	0.022
Elephant in family group	946	109	86	290009.3	117	195	<>	2053.4	0.485
Elephant carcass 4	17	2		254.8984	189	2	<>	50.2	0.009

NORTH WEST

Stratum NW HD

Area: 4896 Km2 Sampling intensity: 25.01 %

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. Out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	4	1	3	11.99	171.9	4 <> 11	0.001
Elephant in family group	188	47	47	6804.6	87.1	94 <> 352	0.038
Elephant carcass 4	4	1		11.99	171.9	1 <> 11	0.001

Stratum NW LDN

Area: 11712 Km2 Sampling intensity: 2.65 %

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. Out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	38	1	1	1385.44	203.9	2 <> 115	0.003
Elephant carcass 2	38	1	0	1385.55	203.9	1 <> 115	0.003

Stratum NW LDS

Area: 12995 Km2 Sampling intensity: 2.77 %

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. Out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	0	0	3				0.000
Elephant in family group	0	0	34				0.003

Stratum NW TC1 (Ugab R.)

Area: 82 Km2 Sampling intensity: 100 %

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	4	4					0.049
Elephant in family group	25	25					0.304

Stratum NW TC2 (Huab R.)

Area: 106 Km2 Sampling intensity: 100 %

ESTIMATES:

SPECIES	Pop. est.	No. Seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	1	1					0.009
Elephant in family group	11	11					0.104
Elephant carcass 4	1	1					0.009

Stratum NW TC3 (Springbok R.)

Area: 28 Km2 Sampling intensity: 100 %

ESTIMATES:

SPECIES	Pop. est.	No. Seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
		Nil					

Stratum NW TC4 (Upper Hoanib R.)

Area: 51 Km2 Sampling intensity: 100 %

ESTIMATES:

SPECIES	Pop. est.	No. Seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	1	1					0.020

Stratum NW TC5 (Lower Hoanib R.)

Area: 49 Km2 Sampling intensity: 100 %

ESTIMATES:

SPECIES	Pop. est.	No. Seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	5	5					0.102
Elephant in family group	26	26					0.529

Stratum NW TC6 (Hoarisib R.)

Area: 131 Km2 Sampling intensity: 100 %

ESTIMATES:

SPECIES	Pop. est.	No. seen	No. out	Variance	95%cl %est.	95%Range	Dens /Km²
Elephant bull	4	4					0.031
Elephant in family group	7	7					0.054
Elephant carcass 2	1	1					0.008