Aerial Survey of Elephant, Other Wildlife and Human Activity in Limpopo National Park and the Southern Extension

Mozambique, 28th September - 4th October 2014, Dry Season

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http://www.pgafamilyfoundation.org/

Acronyms

FSO Front Seat Observer.

GLTP Great Limpopo Transfrontier Park.

GPS Global Positioning System.

MIKE Monitoring of Illegal Killing of Elephants.

PAEAS Pan-African Elephant Aerial Survey.

PNL Limpopo National Park.

RSO Rear Seat Observer.

UTC Coordinated Universal Time.

WCS Wildlife Conservation Society.

Summary

As part of the Pan-African Elephant Aerial Survey (PAEAS), a range wide assessment of savannah elephant populations across Africa, five key elephant population ranges in Mozambique were selected. These sites are estimated to contain > 90% of the countries elephant population [7]. The objective of these surveys was to update the national data base on elephant numbers (including carcasses), distributions and trends using a systematic and scientifically robust method across all sites and within a short survey time window. The aerial surveys used strip sampling methods and adhered to current best practices. The results of these surveys are presented in five technical reports, one for each of the main population ranges (See page 72). This report presents our findings for Limpopo National Park (PNL).

IMPLEMENTED SURVEY EFFORT: An aerial survey of PNL and an additional extension south of the park along the South African boarder took place from the 28th September to the 4th October 2014, covering 15,211km^2. A total of 117 transects were flown, with a total length of 4,200km. The target search intensity (percentage of area covered and animals counted) was 10% for the areas east and north of the park and 20% for the area along the Kruger border. The southern extension was surveyed at 4 - 6%. The mean search rate for the survey was 1.23km^2 per minute.

ELEPHANT POPULATION AND TRENDS: The elephant population in the PNL is estimated at 1,081 animals (95% CI:432 to 1,730). An important extension to this core range is the southern extension along the Kruger border, which is estimated to contain another 173 elephants (95% CI:13 - 456). Earlier estimates of elephants for Limpopo vary and results are likely not to be strictly comparable (see methods section page 73) - however, the 2010 surveys, which are regarded as the more reliable, estimated similar live elephant population numbers as the ones reported here. Carcass ratios are high for this zone - clear evidence that poaching had a major effect on mortality in this population over the last 5 years. The discrepancy between the suggested constant elephant numbers across 2010 and 2014 and high levels of carcass finds might, to some extend, be explained by the trans-boundary movement between Limpopo and Kruger as well as possible slower rates of decay of carcasses due to the dry condition allowing for longer accumulation periods.

KEY OBSERVATIONS AND SUMMARY RESULTS:

A summary of the survey estimates (with their 95% confidence ranges is given in the following three tables below. The first table provides a detailed summary on all elephant observations and estimations. The second and third table provide summaries for wildlife and livestock respectively. A detailed description of the table variables and the observation categories is provided in the methods section.

Summary of Results for the Limpopo N.P.

Table 0.1.: Summary table of population estimates for elephant and elephant carcasses in the Limpopo National Park.

Observation	Observed	Estimated	lower CI	upper CI	PRP
All Elephant	**185**	**1081**	**432**	**1730**	**60**
Elephant bulls	30	236	30	496	110
Elephant cows	155	845	235	1456	72
All Elephant carcass	**34**	**227**	**134**	**319**	**41**
Fresh elephant carcass	0				
Recent elephant carcass	2	10	2	27	183
Old elephant carcass 3	14	90	31	149	66
Old elephant carcass 4	18	128	59	196	54

Table 0.2.: Summary table of population estimates for wildlife in the Limpopo National Park.

Observation	Observed	Estimated	lower CI	upper CI	PRP
Baboon	9	48	12	83	74
Buffalo	216	1339	216	2518	88
Bushbuck	1	9	1	29	205
Bushpig	20	155	20	298	92
Elephant carcass 3 and 4	32	217	126	309	42
Giraffe	13	71	22	121	69
Ground hornbill	26	212	26	398	88
Hippo	12	57	12	121	112
Impala	179	1126	477	1775	58
Kudu	208	1468	757	2178	48
Nyala	201	1394	906	1881	35
Ostrich	39	223	47	399	79
Other carcass	25	184	100	267	45
Roan	1	5	1	13	182
Sable	3	14	3	33	132
Small antelope	22	165	64	266	61
Vervet monkey	3	28	3	62	119
Warthog	3	24	3	63	166
Waterbuck	56	271	56	571	110
Wildebeest	49	247	73	422	70
Zebra	74	394	150	639	62

Table 0.3.: Summary table of population estimates for livestock in the Limpopo National Park.

Observation	Observed	Estimated	lower CI	upper CI	PRP
Shoats	1024	8140	5051	11229	38
Cattle	4576	35699	25921	45477	27

Summary of Results for the Southern Extension

Table 0.4.: Summary table of population estimates for elephant and elephant carcasses south of Limpopo N.P.

Observation	Observed	Estimated	lower CI	upper CI	PRP
All Elephant	**13**	**173**	**13**	**456**	**164**
Elephant bulls	0				
Elephant cows	13	173	13	456	164
All Elephant carcass	**1**	**23**	**1**	**74**	**220**
Fresh elephant carcass					
Recent elephant carcass					
Old elephant carcass 3	1	23	1	74	220
Old elephant carcass 4					

Table 0.5.: Summary table of population estimates for wildlife south of Limpopo N.P.

Observation	**Observed**	**Estimated**	**lower CI**	**upper CI**	**PRP**
Baboon	2	36	2	96	163
Buffalo	18	357	18	984	176
Bushbuck	1	13	1	44	233
Bushpig	2	27	2	88	231
Elephant carcass 3 and 4	1	23	1	74	220
Giraffe	5	66	5	221	232
Impala	25	332	25	977	194
Kudu	41	692	41	1372	98
Nyala	6	80	6	190	138
Ostrich	1	13	1	44	229
Other carcass	4	63	4	144	129
Small antelope	19	282	74	490	74
Warthog	5	66	5	176	166

Table 0.6.: Summary table of population estimates for livestock south of Limpopo N.P.

Observation	**Observed**	**Estimated**	**lower CI**	**upper CI**	**PRP**
Shoats	20	462	20	1275	176
Cattle	285	5724	303	11145	95

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1. Introduction

The survey of the PNL are part of a larger Pan-African elephant assessment, PAEAS, which have been conducted simultaneously across 18 range states across Africa in 2014 and 2015.The primary objective of this savannah elephant range wide survey initiative is to derive a current and accurate account of the elephant populations status and trends across this species range. This information is of great urgency due to the observed massive declines of key populations across the continent for which time series data are available. Simultaneously, illegal trade in elephant, wildlife and timber resources from the African continent has increased significantly over the last years. The threats to the continues survival of elephants, even short term, across large parts of the range is evident. Addressing current uncertainty of the range wide elephant population status, by using current and scientific robust data, will allow for trends to be measured and ultimately to stimulate conservation action in order to secure critical habitat and elephants.
Within Mozambique five key population sites were selected for assessment. The selection of the sites was done based on available datasets and were sourced from published literature, including (Ntumi et al. (2009), the National Aerial Surveys commissioned by Agreco (2008) and the African Elephant Data base[1]. The objective was to cover an area capturing at a minimum 90% of the know elephant population within Mozambique. The key sites and current elephant range are shown in Figure 1.1.
The aerial surveys of the PNL zone were undertaken by the Wildlife Conservation Society (WCS) and local partners, in collaboration with the Ministry of Agriculture and Food Security, between the 25th September and the 5th October 2014. This is the fourth aerial survey conducted across the park (2007, 2010, 2013). A full reference list of earlier surveys is provided in the bibliography. Sampling of the survey zone was based on stratified systematic transect sampling with a targeted sampling intensity of between 10% and 20% within the PNL and <6% in the southern extension.
PNL is part of the Great Limpopo Transfrontier Park (GLTP) which straddle the borders of Mozambique, South Africa and Zimbabwe and combined cover more than 37,000 km^2. The conservation landscape include the Kruger National Park in South Africa, Limpopo, Banhine and Zivane National Parks in Mozambique and Gonarezhou in Zimbabwe as well as a number of privately and state-owned conservation areas. PNL was declared a National Park in 2001 and extends over 11,200 km^2. The parks vegetation can be broadly categorized into four vegetation communities; a Mopane woodland and shrubland dominated by *Colophospermum mopane*, a mixed bushveld dominated by *Acacia nigrescens, Combretum paniculatum, Combretum imberbe, Sclerocarya birrea*, and *Dichrostachys cinerea,* the sandveld, a particularly important and diverse ecotype which include *Bapphia massaiensis, Afzelia quanzensis, Strychnos spp., Terminalia sericea, Albizia spp.* and extensive riverine woodlands with *Trichilia emetica, Ficus*

[1] http://www.elephantdatabase.org/

sycomorus, Xanthocercis zambesiaca, Diospyros mespiliformis, Acacia robusta, Acacia xanthophloea, Kigelia africana and the palms *Phoenix reclinata* and *Hyphaene natalensis*. This reports presents the results of the 2014 surveys for the PNL and the southern extension. Estimates are provided for elephant, wildlife and livestock populations. Locations and maps are provided for human activity. The report is structured with the results in the main section. This is followed by a discussion of the key observations with a particular focus on elephants. Finally a set of key recommendations based on the findings is provided. The appendix provides the details of the survey design and sampling methods. It also contains additional results, a quantitative assessment of the survey implementation and tables with strata specific estimates.

1.1. Objectives

The objectives of the survey was to obtain the following information for the Limpopo zone:

1. Determine the number of elephants, elephant carcasses and other large bodied (<15 kg) wildlife and livestock
2. Document the spatial distribution of elephants, elephant carcasses and other large bodied (<15 kg) wildlife and livestock
3. Document the type and spatial distribution of human activity

Printing: Considering the report contains a large number of axillary information pages we recommend you to print the following pages. **Results** without the methods and meta data analysis: Pages 1 to 72. **Results & Methods** without survey design files and axillary tables: Pages 1 to 101.

1.2. Elephant Range in Mozambique

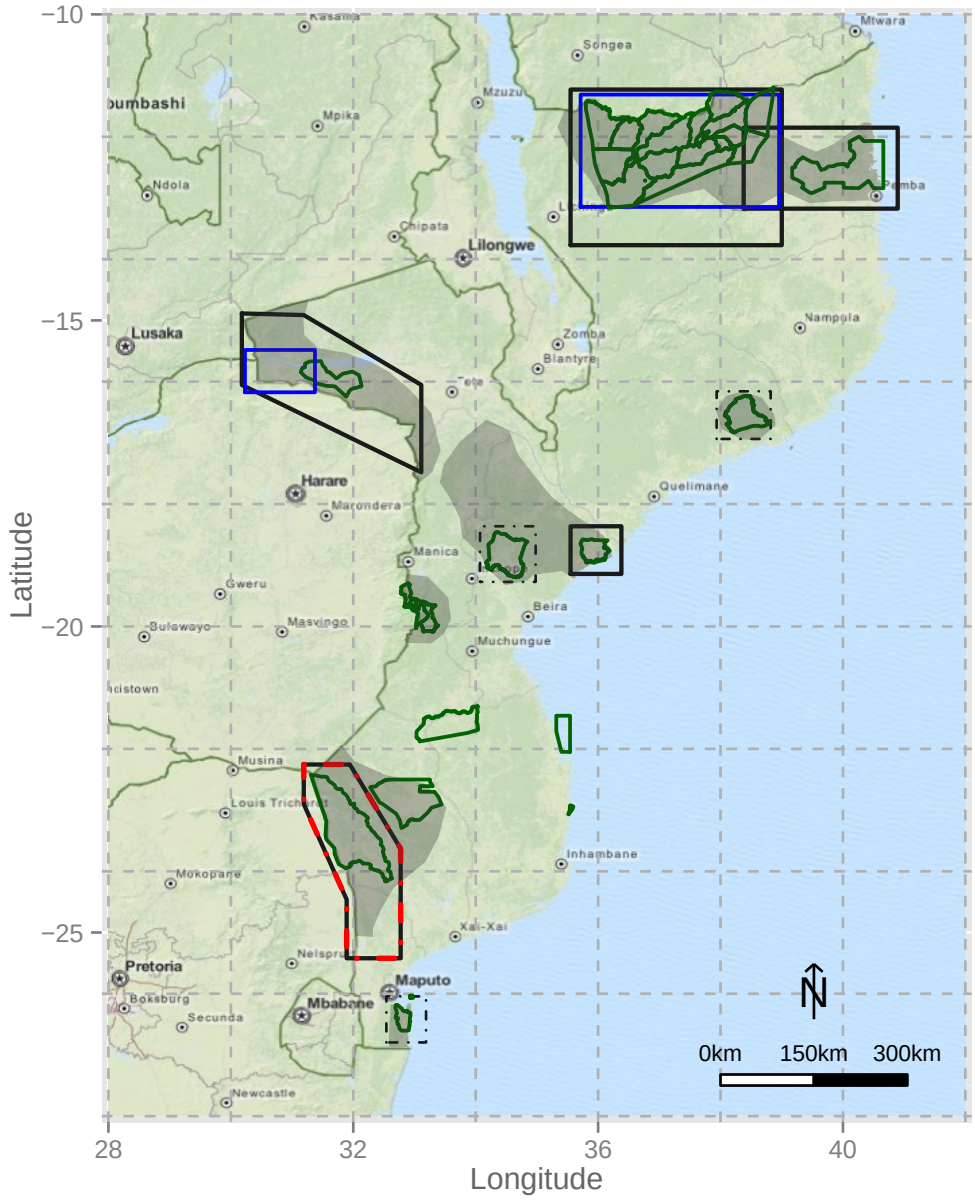

Figure 1.1.: Current core elephant range areas in Mozambique represented by grey shading. The Limpopo survey area and focus of this report is indicated in a red-black dashed line. MIKE sites are indicated in solid blue box. Other surveys conducted by partners during 2014 are indicated in a grey dashed box.

1.3. Survey Zone

Figure 1.2 shows Limpopo N.P. and adjacent survey zones. The red lines outline strata discussed in this report. Aerial surveys for Kruger N.P.had not been conducted. Green polygons are protected areas.

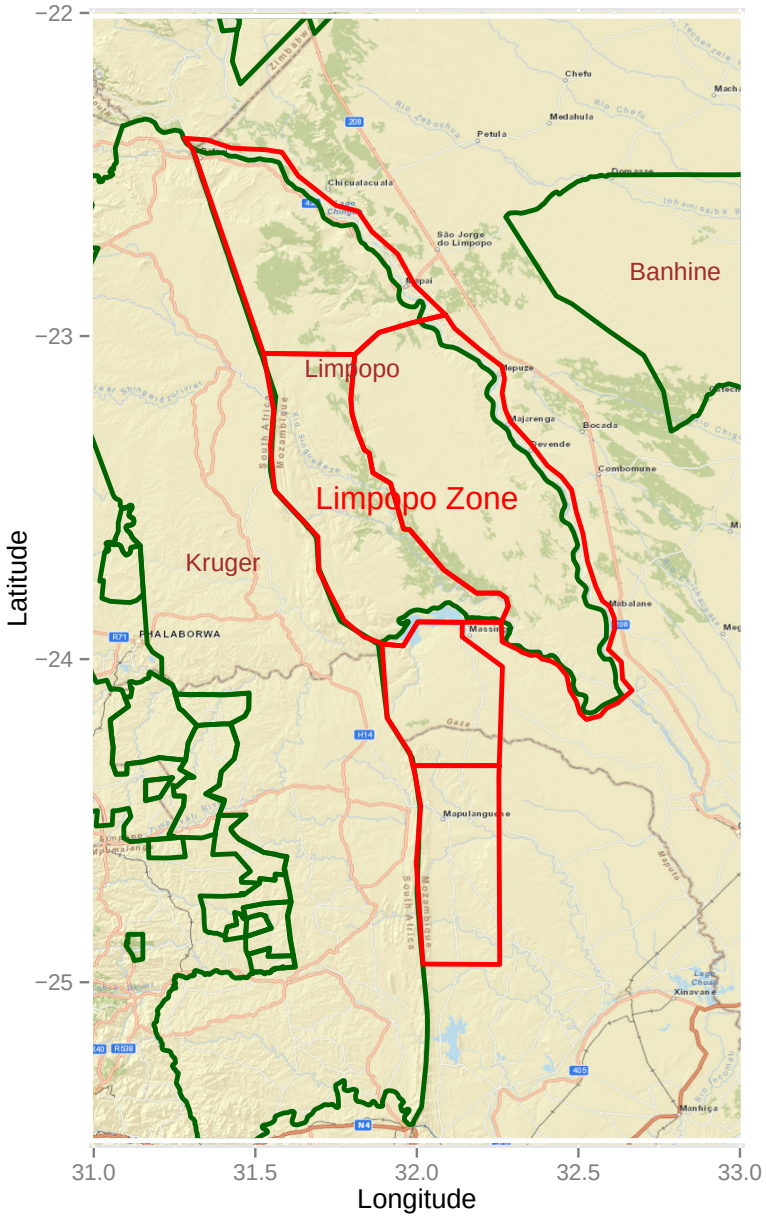

Figure 1.2.: The Limpopo survey zone and adjacent areas.

1.4. Survey Stratification

Figure 1.3 shows the strata of the PNL survey zone. The stratum names provided here are also used in the species population estimation tables in the following results section. The reader should refer to this map for interpreting the results by stratum.

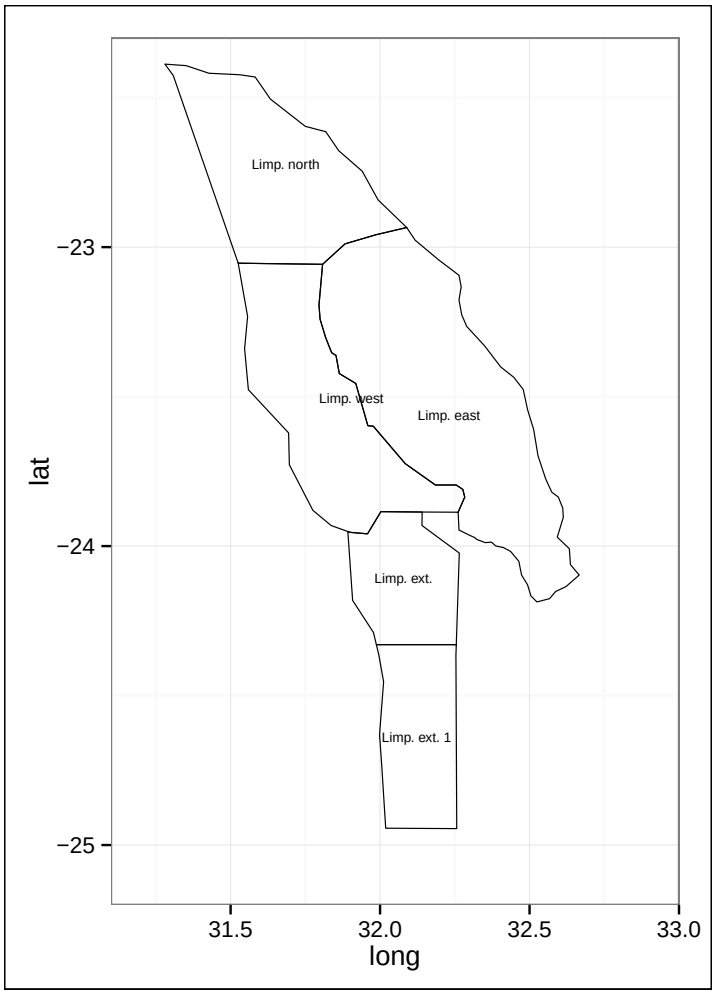

Figure 1.3.: Strata of the Limpopo survey zone.

2. Survey Results

2.1. Observation summary

Table 2.1.: Frequency of observation encounter and counts per species. Table is ordered by animals counted inside the sample.

	Frequency[a]				Counted[b]			
Species	Inside Sample[c]	Outside Sample[d]	Recce[e]	Total	Inside Sample	Outside Sample	Recce	Total
Cattle	353	125	20	498	4861	1858	364	7083
Shoats	73	17	2	92	1044	254	29	1327
Kudu	74	16	7	97	249	35	23	307
Buffalo	28	20	21	69	234	538	219	991
Nyala	86	9	4	99	207	22	12	241
Impala	24	8	2	34	204	62	7	273
Elephant	28	19	0	47	198	200	0	398
Elephant cows	20	19	10	49	168	200	89	457
Zebra	16	14	5	35	74	56	27	157
Waterbuck	5	1	1	7	56	2	1	59
Wildebeest	9	5	3	17	49	33	9	91
Ostrich	11	4	0	15	40	5	0	45
Elephant carcass	33	13	0	46	35	13	0	48
Elephant bulls	8	0	3	11	30	0	8	38
Other carcass	28	14	0	42	29	14	0	43
Ground hornbill	8	6	0	14	26	17	0	43
Bushpig	8	1	1	10	22	1	1	24
Giraffe	10	4	8	22	18	12	16	46
Old elephant carcass 3	14	9	2	25	15	9	2	26
Hippo	3	0	3	6	12	0	8	20
Baboon (troops)	11	2	0	13	11	2	0	13
Warthog	4	0	0	4	8	0	0	8
Sable	2	4	1	7	3	4	4	11
Vervet monkey (troops)	3	2	0	5	3	2	0	5
Bushbuck	2	0	0	2	2	0	0	2
Elephant carcass 1 and 2	1	1	0	2	2	1	0	3
Recent elephant carcass	1	1	0	2	2	1	0	3
Roan	1	0	1	2	1	0	5	6

[a] count of how many times the species was recorded.
[b] sum of all animals observed.
[c] observation made inside the sample strip.
[d] observations made outside the sampling strip but on transect (systematic coverage).
[e] adhoc observations made during the survey (non systematic).
[f] refers to troops observed.

Presentation of Results

The results in the report are provided in the following format. Species are arranged in alphabetic order with the following exceptions; the results for elephants and elephant carcasses are provided at the beginning and observations of primates and birds are provided in separate sections following the main wildlife estimates. Observations of carnivores are provided after Zebra. For each species a table is provided with stratum specific estimates and associate parameters, as outlined below. A species global (survey zone) population estimate is provided at the bottom of each table. This is followed by a graph providing the trend-line of estimates across earlier, reported, surveys. Trend line graphs are provided with 95% confidence error bars, if these were available. Finally, for each observation species, or category for human activity, a map is provided with all observation locations. Observations made inside and outside the sample transect are differentiated by colour.

The estimation table column headings are explained in the following. Details of how these have been derived can be found in the analysis section in the appendix (page 80).

Stratum = the name of stratum,

Observed = total number of objects seen within the survey strip,

Estimate = population estimate for given species,

Variance = the variance of the population estimate,

lower CI = the lower 95 % confidence limit of the population estimate [1] [2],

upper CI = the upper 95 % confidence limit of the population estimate,

PRP = the Percent Relative Precision provides a relative index of precision of the estimate. It is calculated as $\frac{Conf.Inter.}{(\hat{Y}/100)}$,

Density = the estimated density of the species per km^2.

[1] Confidence intervals provide bounds for the most likely range of the unknown population average estimated. Its is impacted by sample variability and sample size.

[2] If the calculated lower confidence limit was less than the actual number of observed animals within the strip than this was replaced with this actual number.

2.2. Elephant

2.2.1. African savannah Elephant (*Loxodonta africana africana)*

All elephant (family and bull groups)

Table 2.2.: Population estimates for elephant in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	9	84	4904	9	227	169	0.0153
lim14_north	34	320	46329	34	774	142	0.1004
lim14_west	142	677	55882	202	1152	70	0.2083
Total	**185**	**1081**	**107114**	**432**	**1730**	**60**	**0.0903**

Table 2.3.: Population estimates for elephant in the southern extension.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_extsouth	13	173	17437	13	485	181	0.1133
Total	**13**	**173**	**17437**	**13**	**456**	**164**	**0.0533**

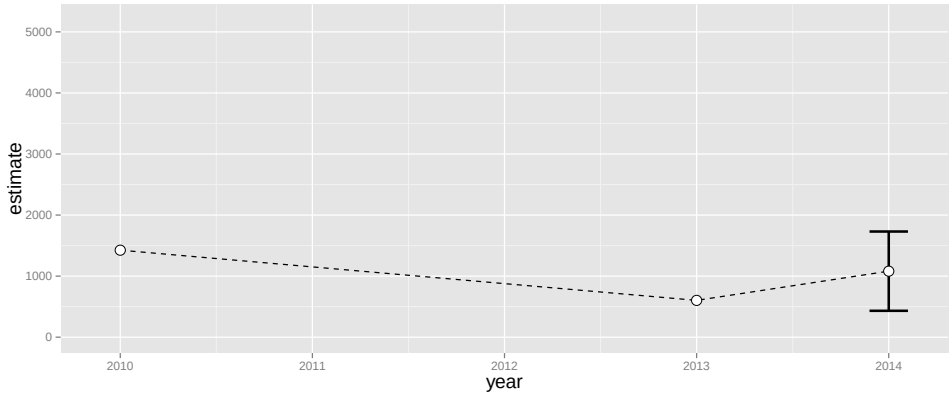

Figure 2.1.: Trends in elephant population estimates with 95% C.I. intervals.

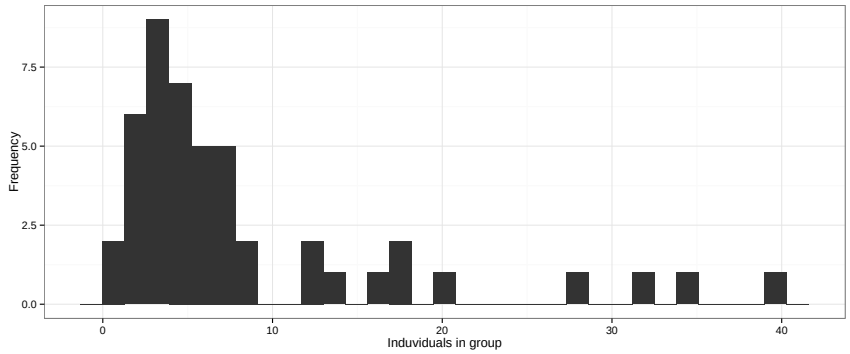

Figure 2.2.: Observed group size distribution of elephants.

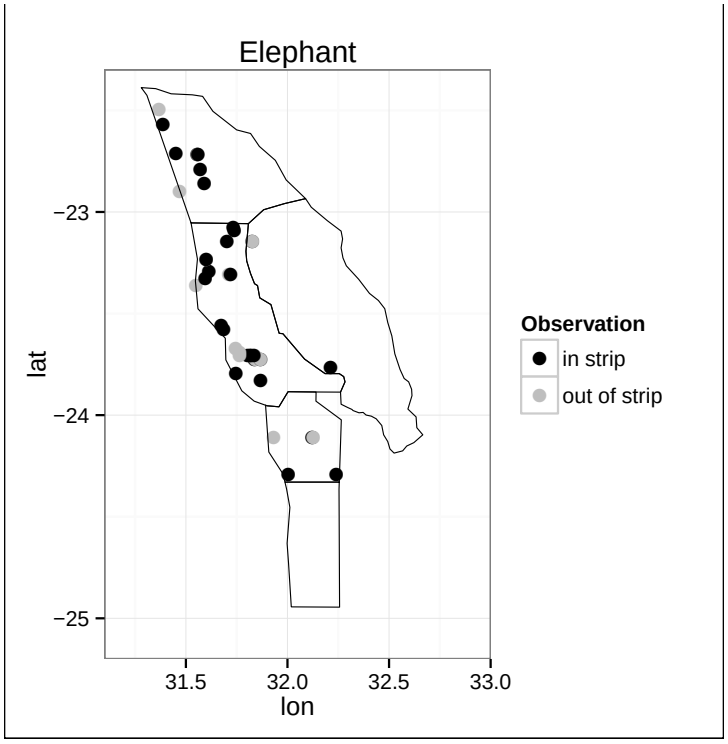

Figure 2.3.: All elephant sightings.

Elephant family groups

Table 2.4.: Population estimates for elephant family groups in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	2	19	374	2	58	210	0.0034
lim14_north	21	198	38242	21	610	209	0.0620
lim14_west	132	629	56211	153	1105	76	0.1937
Total	**155**	**845**	**94827**	**235**	**1456**	**72**	**0.0706**

Table 2.5.: Population estimates for elephant family groups in the southern extension.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_extsouth	13	173	17437	13	485	181	0.1133
Total	**13**	**173**	**17437**	**13**	**456**	**164**	**0.0533**

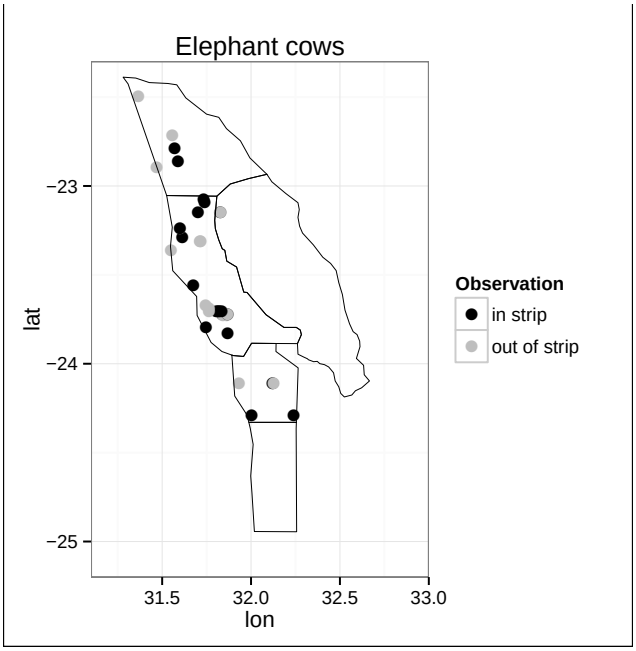

Figure 2.4.: Elephant family group sightings.

Elephant bull groups

No bull groups were seen in the southern extension.

Table 2.6.: Population estimates for elephant bull groups in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	7	66	4619	7	204	211	0.0119
lim14_north	13	122	11916	13	353	188	0.0384
lim14_west	10	48	638	10	98	107	0.0147
Total	**30**	**236**	**17173**	**30**	**496**	**110**	**0.0197**

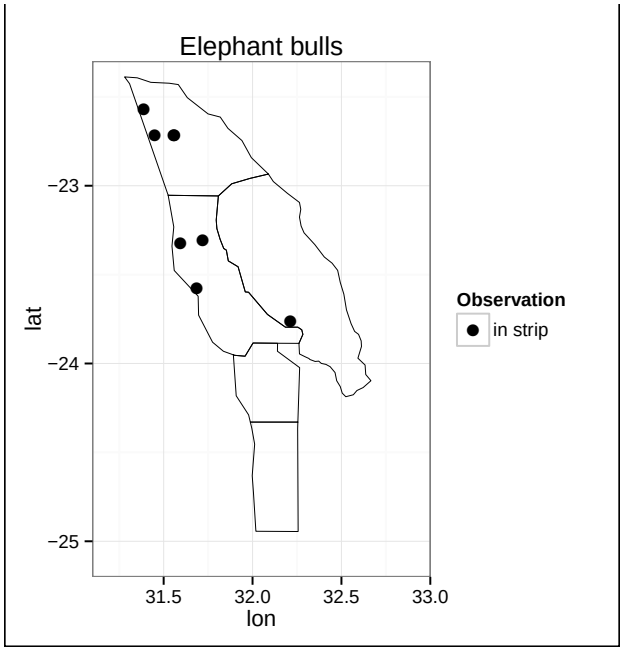

Figure 2.5.: Elephant bull groups sightings.

2.2.2. Elephant carcasses

All carcasses

Table 2.7.: Population estimates for elephant carcass in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	6	56	839	6	115	105	0.0102
lim14_north	8	75	817	15	136	80	0.0236
lim14_west	20	95	517	50	141	48	0.0293
Total	**34**	**227**	**2173**	**134**	**319**	**41**	**0.0190**

Table 2.8.: Population estimates for elephant carcass in the southern extension.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_extsouth1	1	23	560	1	81	250	0.0135
Total	**1**	**23**	**560**	**1**	**74**	**220**	**0.0071**

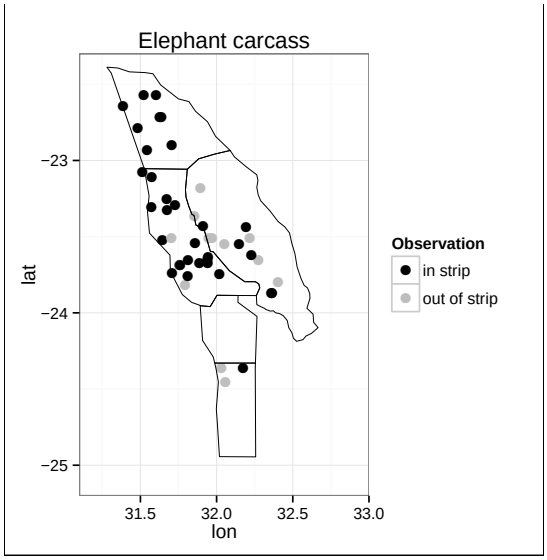

Figure 2.6.: Elephant carcass sightings.

Carcass ratios

Table 2.9.: Carcass ratios for the individual the Limpopo survey zone.

Strata	Population estimate Live Elephants	Population Estimate 1+2 Carcasses	Population Estimate All Carcasses	1+2 Carcass Ratio	Overall Carcass Ratio
Limp. east	84		56		40.00
Limp. ext.	173				0.00
Limp. ext. 1	-		23		100.00
Limp. north	320		75		19.05
Limp. west	677	10	95	1.39	12.35
Summary	**1254**	**10**	**250**	**0.75**	**16.63**

Fresh elephant carcass (carcass category 1)

No elephant carcass class 1 were observed on survey or any of the recce flights conducted.

Recent elephant carcass (carcass category 2)

Table 2.10.: Population estimates for Recent elephant carcass in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_west	2	10	77	2	27	185	0.0029
Total	**2**	**10**	**77**	**2**	**27**	**183**	**0.0008**

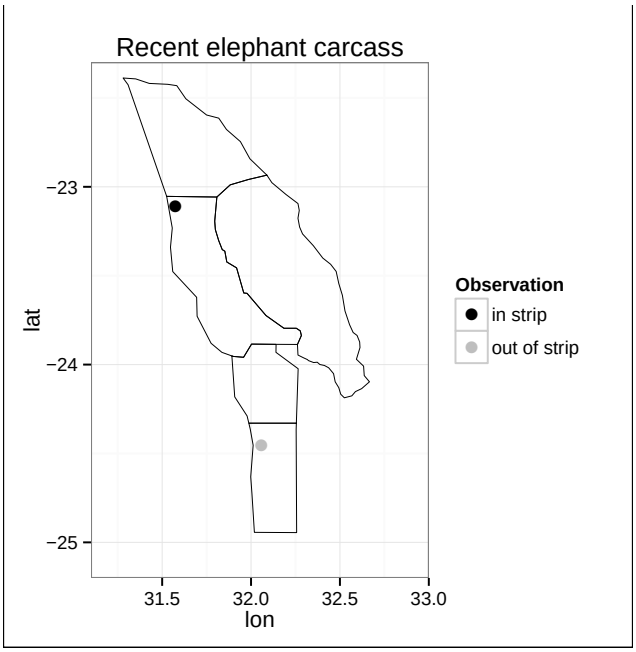

Figure 2.7.: Elephant carcasses (category 2) sightings.

Old elephant carcass (carcass category 3)

Table 2.11.: Population estimates for Old elephant carcass 3 in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	4	38	530	4	84	125	0.0068
lim14_north	1	9	94	1	30	218	0.0030
lim14_west	9	43	263	10	75	76	0.0132
Total	**14**	**90**	**887**	**31**	**149**	**66**	**0.0075**

Table 2.12.: Population estimates for Old elephant carcass 3 in the southern extension.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_extsouth1	1	23	560	1	81	250	0.0135
Total	**1**	**23**	**560**	**1**	**74**	**220**	**0.0071**

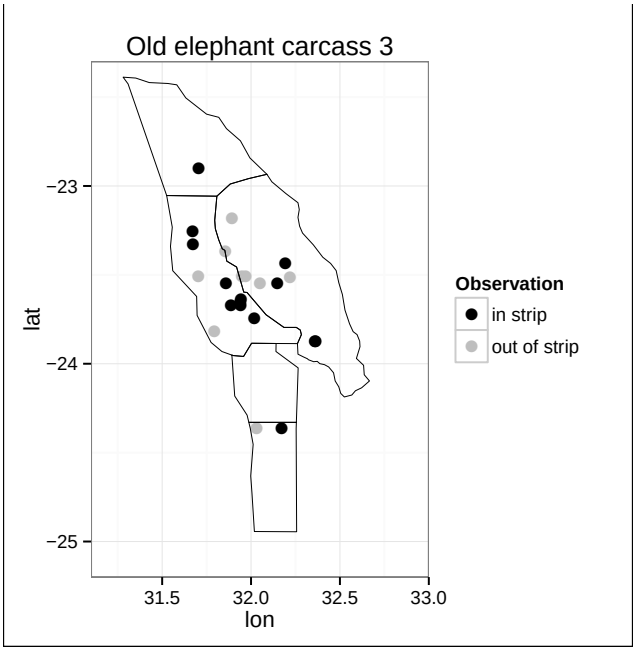

Figure 2.8.: Elephant carcasses (category 3) sightings.

Old elephant carcass (carcass category 4)

Table 2.13.: Population estimates for Old elephant carcass 4 in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	2	19	177	2	46	144	0.0034
lim14_north	7	66	833	7	127	92	0.0207
lim14_west	9	43	182	16	70	63	0.0132
Total	**18**	**128**	**1192**	**59**	**196**	**54**	**0.0107**

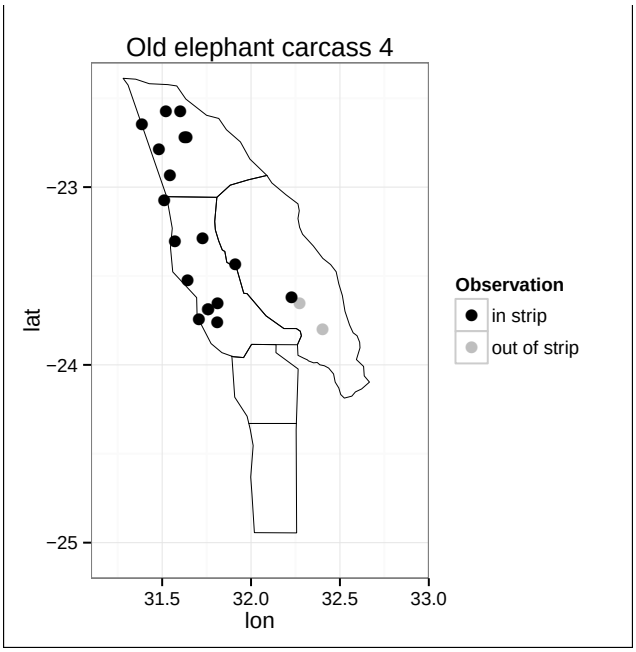

Figure 2.9.: Elephant carcasses (category 4) sightings.

2.3. Wildlife Observations

Cape buffalo *(Syncerus caffer caffer)*

Table 2.14.: Population estimates for Buffalo in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	56	525	245172	56	1533	192	0.0949
lim14_north	11	104	3506	11	229	121	0.0325
lim14_west	149	710	104366	149	1359	91	0.2186
Total	**216**	**1339**	**353043**	**216**	**2518**	**88**	**0.1119**

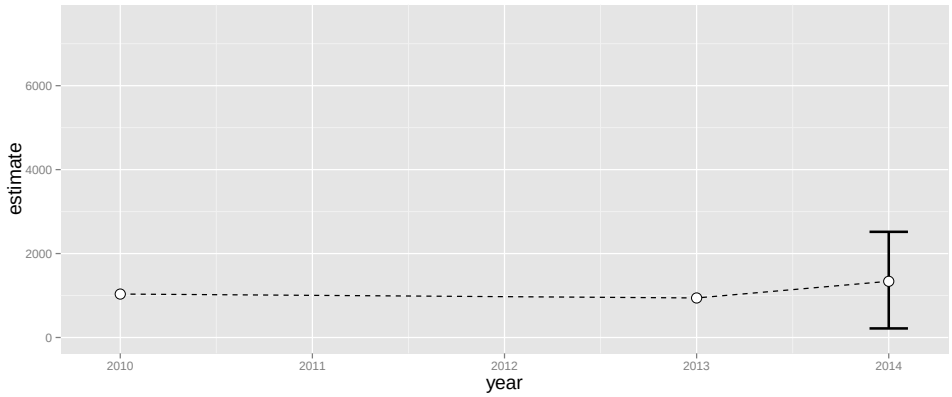

Figure 2.10.: Trends in buffalo population estimates with 95% C.I. intervals.

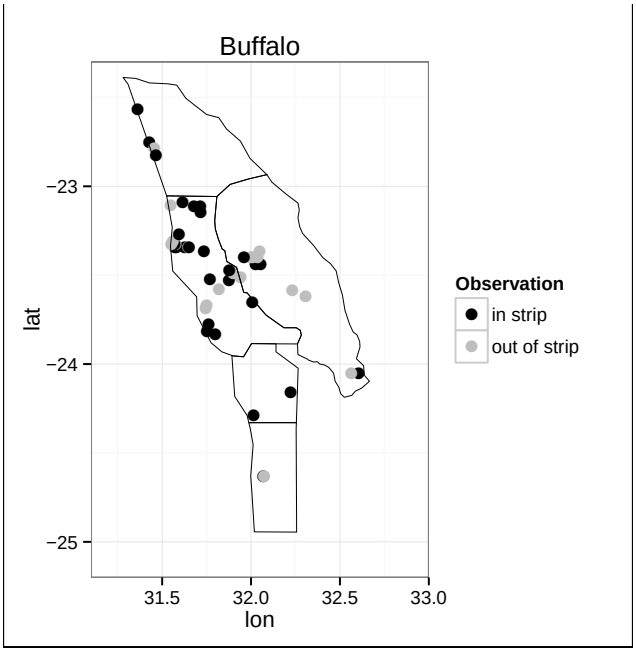

Figure 2.11.: Cape Buffalo sightings.

Bushbuck *(Tragelaphus scriptus)*

Table 2.15.: Population estimates for Bushbuck in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	1	9	94	1	29	210	0.0017
Total	1	9	94	1	29	205	0.0008

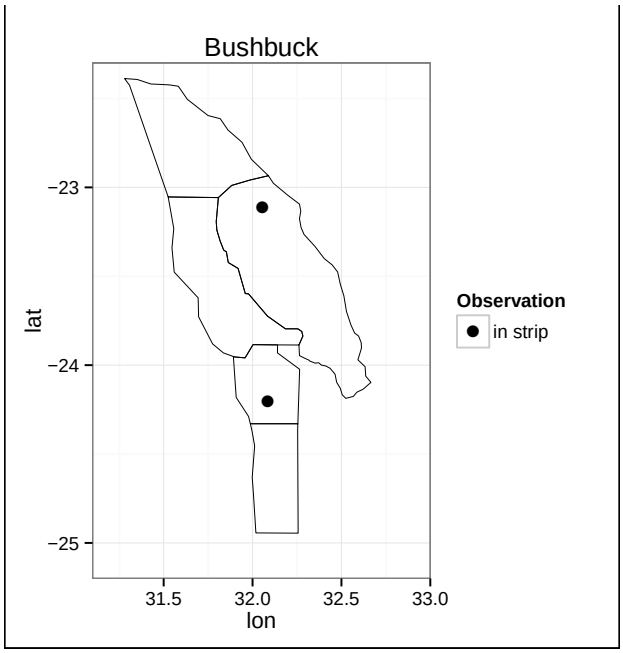

Figure 2.12.: Bushbuck sightings.

Bushpig *(Potamochoerus porcus)*

The following are the estimates for bushpig. No observations of this species were made in 2010 or 2011.

Table 2.16.: Population estimates for Bushpig in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	10	94	3691	10	217	132	0.0170
lim14_north	3	28	907	3	92	225	0.0089
lim14_west	7	33	543	7	80	140	0.0103
Total	20	155	5142	20	298	92	0.0130

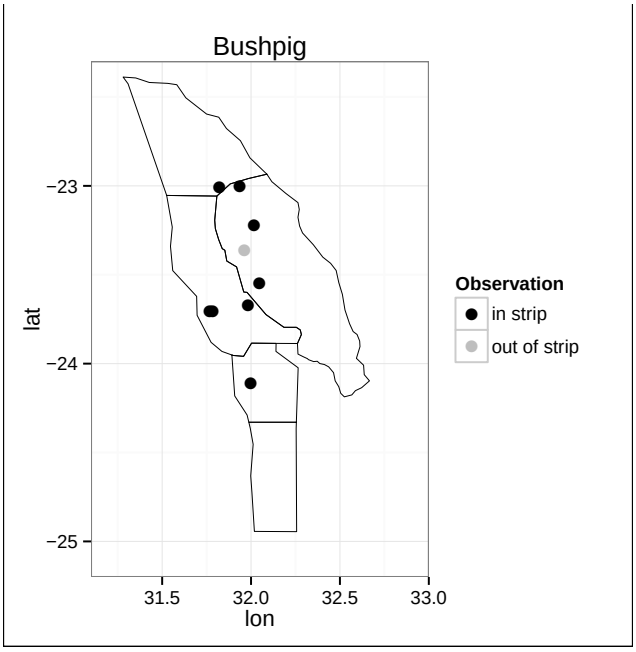

Figure 2.13.: Bushpig sightings.

Giraffe*(Giraffa camelopardalis)*

Table 2.17.: Population estimates for Giraffe in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_north	2	19	182	2	47	151	0.0059
lim14_west	11	52	440	11	95	80	0.0161
Total	13	71	622	22	121	69	0.0060

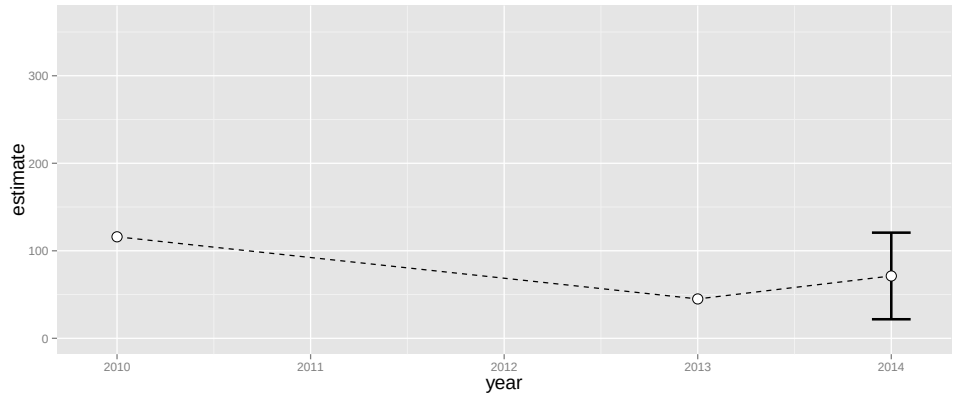

Figure 2.14.: Trends in giraffe population estimates with 95% C.I. intervals.

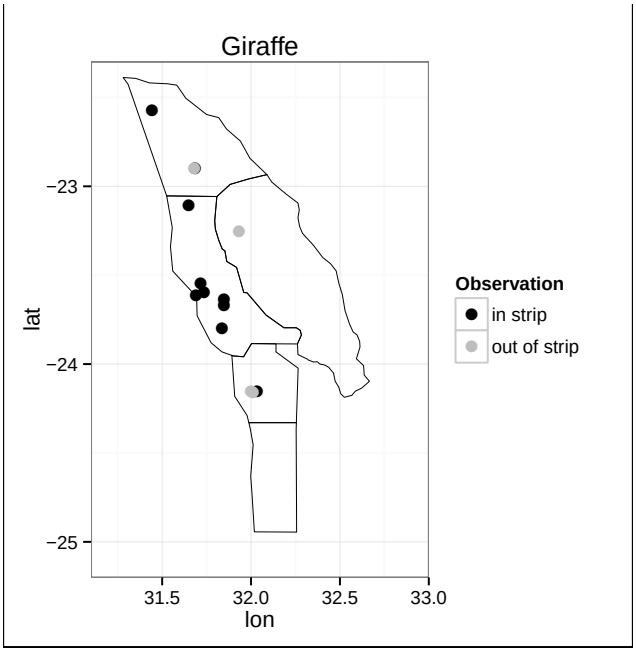

Figure 2.15.: Giraffe sightings.

Hippopotamus*(Hippopotamus amphibius)*

Table 2.18.: Population estimates for Hippo in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_west	12	57	1041	12	122	113	0.0176
Total	**12**	**57**	**1041**	**12**	**121**	**112**	**0.0048**

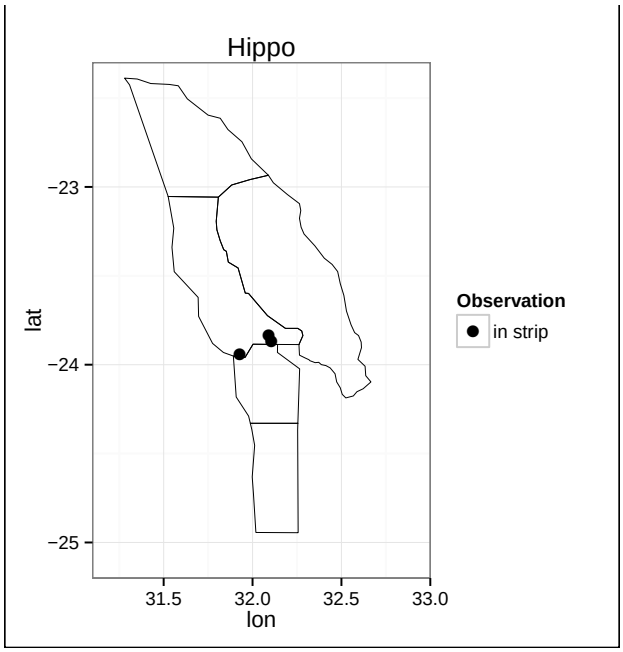

Figure 2.16.: Hippo sightings.

Impala *(Aepyceros melampus johnstoni)*

Table 2.19.: Population estimates for Impala in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	45	422	46172	45	859	104	0.0763
lim14_north	14	132	18424	14	418	217	0.0413
lim14_west	120	572	42357	158	985	72	0.1760
Total	**179**	**1126**	**106953**	**477**	**1775**	**58**	**0.0940**

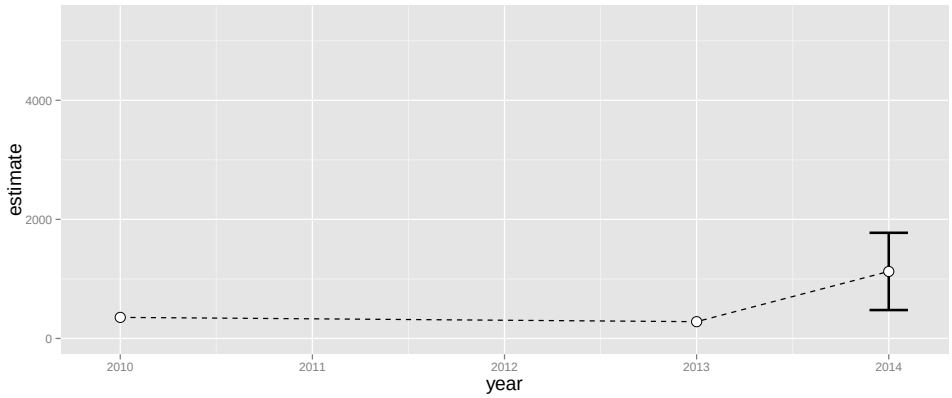

Figure 2.17.: Trends in impala population estimates with 95% C.I. intervals.

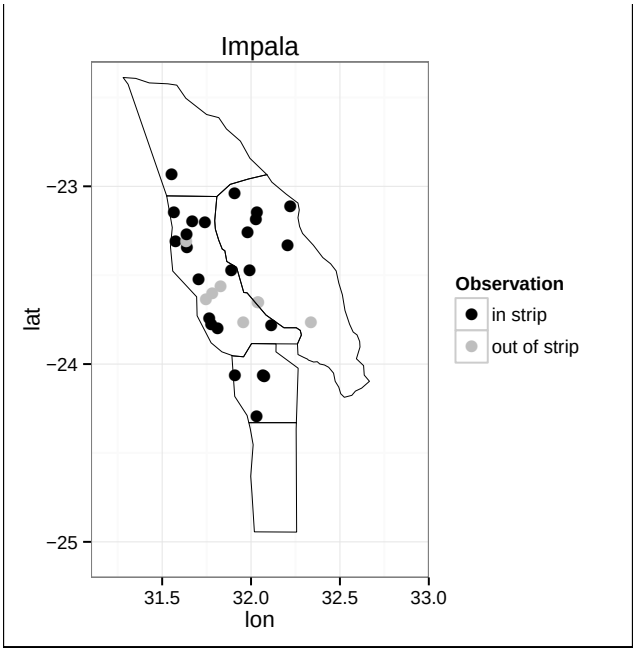

Figure 2.18.: Impala sightings.

Greater Kudu *(Tragelaphus strepsiceros)*

Table 2.20.: Population estimates for Kudu in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	71	666	85612	71	1261	89	0.1204
lim14_north	32	301	23939	32	628	108	0.0945
lim14_west	105	500	18739	225	775	55	0.1540
Total	**208**	**1468**	**128289**	**757**	**2178**	**48**	**0.1226**

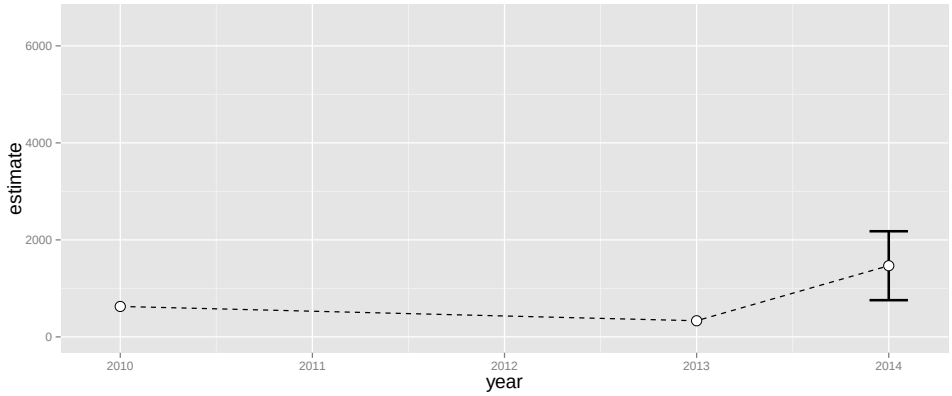

Figure 2.19.: Trends in greater kudu population estimates with 95% C.I. intervals.

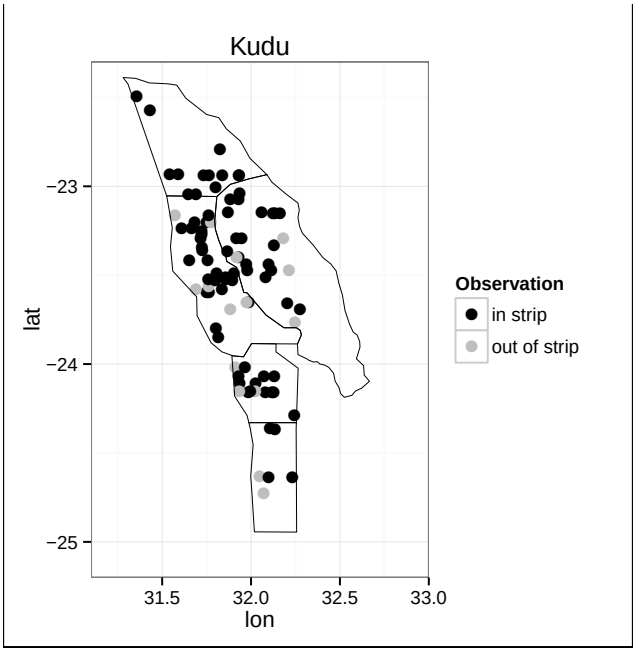

Figure 2.20.: Greater kudu sightings.

Nyala *(Tragelaphus angasii)*

Table 2.21.: Population estimates for Nyala in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	35	328	11628	109	548	67	0.0593
lim14_north	59	556	37066	149	962	73	0.1742
lim14_west	107	510	11668	293	727	43	0.1570
Total	201	1394	60362	906	1881	35	0.1164

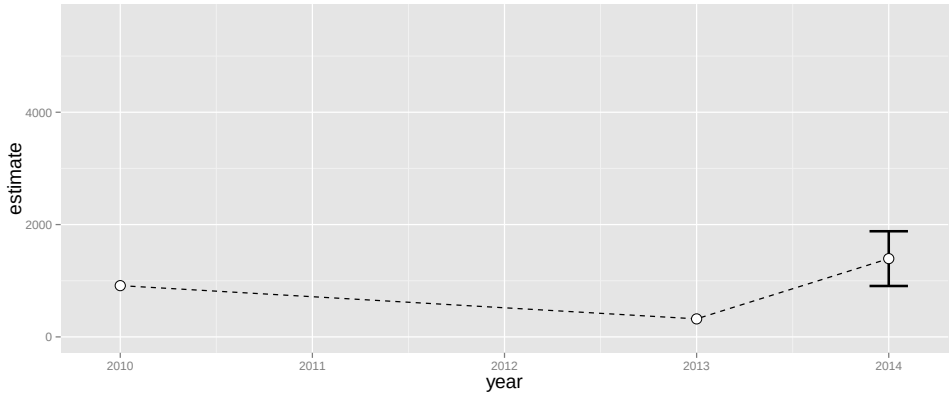

Figure 2.21.: Trends in nyala population estimates with 95% C.I. intervals.

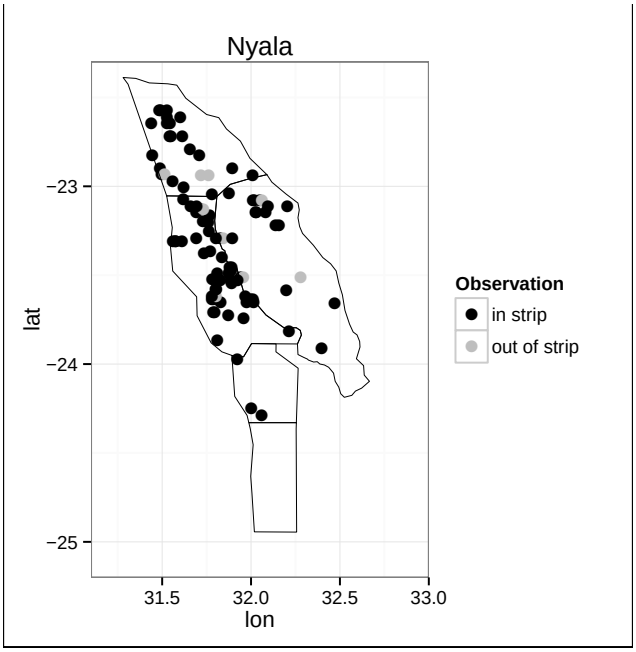

Figure 2.22.: Nyala sightings.

Sable Antelope*(Hippotragus niger)*

Table 2.22.: Population estimates for Sable in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_west	3	14	91	3	33	134	0.0044
Total	**3**	**14**	**91**	**3**	**33**	**132**	**0.0012**

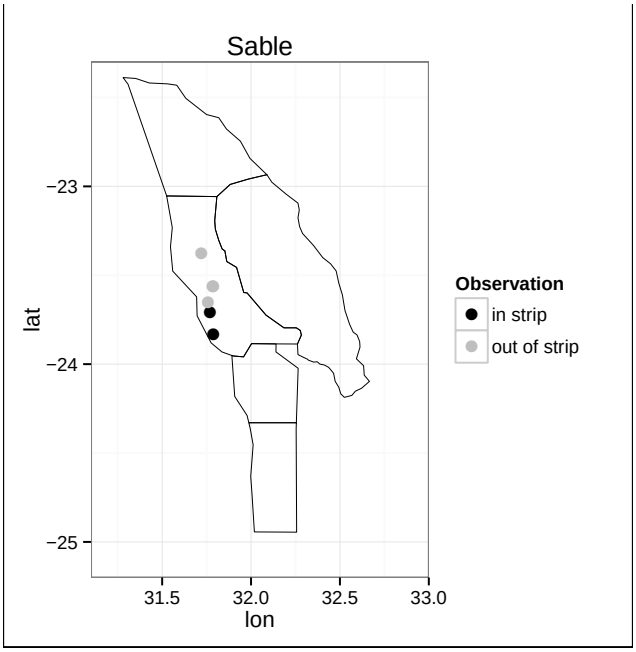

Figure 2.23.: Sable sightings.

Small antelopes*(Grysbuck, duiker, Steenbuck)*

Table 2.23.: Population estimates for Small antelope in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	4	38	339	4	75	100	0.0068
lim14_north	9	85	1816	9	175	106	0.0266
lim14_west	9	43	427	9	84	97	0.0132
Total	**22**	**165**	**2582**	**64**	**266**	**61**	**0.0138**

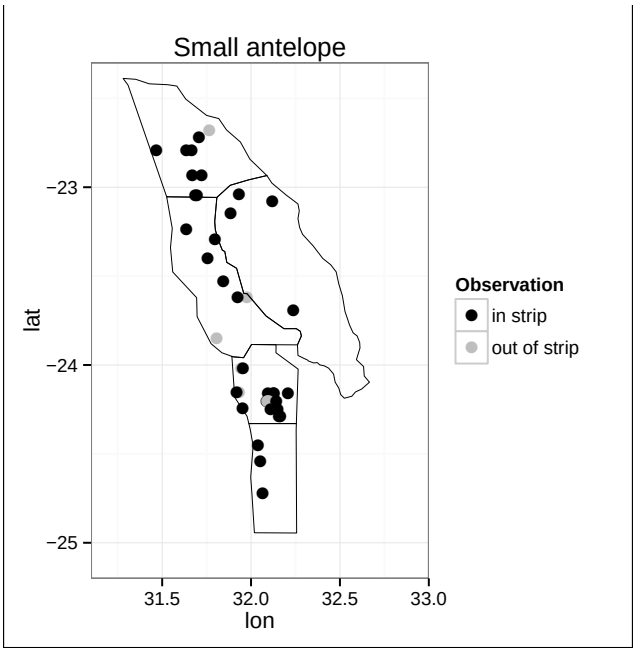

Figure 2.24.: Small antelope sightings.

Common Warthog *(Phacochoerus aethopicus)*

Table 2.24.: Population estimates for Warthog in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	2	19	369	2	58	208	0.0034
lim14_west	1	5	19	1	14	185	0.0015
Total	3	24	388	3	63	166	0.0020

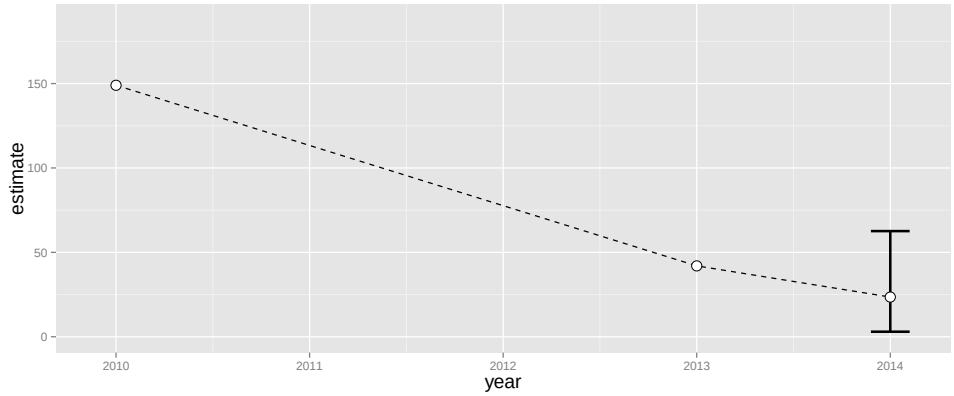

Figure 2.25.: Trends in warthog population estimates with 95% C.I. intervals.

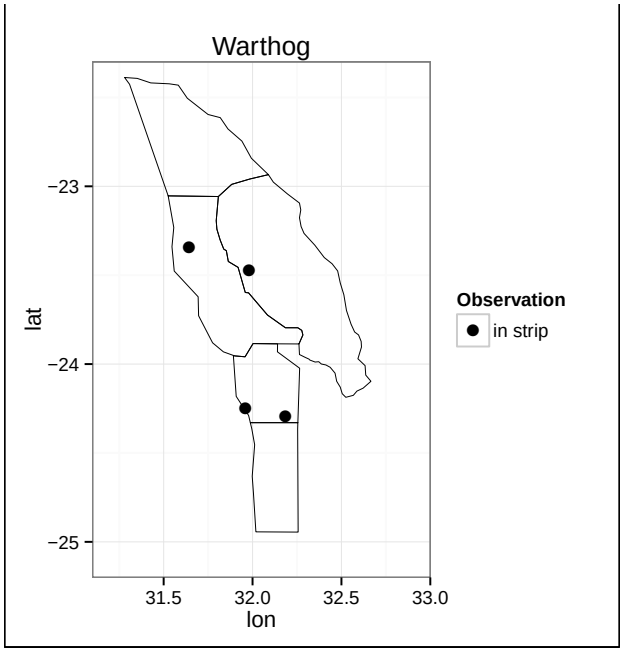

Figure 2.26.: Warthog sightings.

Common Waterbuck *(Kobus ellipsiprymnus)*

Table 2.25.: Population estimates for Waterbuck in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	1	9	94	1	29	210	0.0017
lim14_west	55	262	22759	55	565	116	0.0807
Total	**56**	**271**	**22852**	**56**	**571**	**110**	**0.0227**

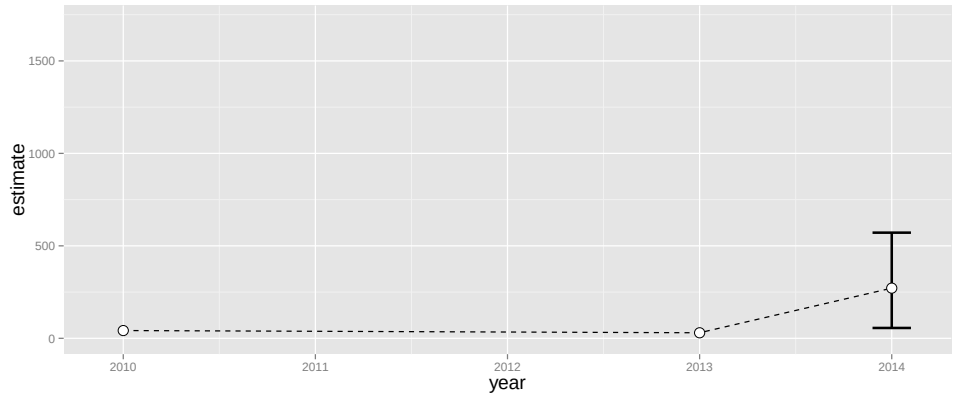

Figure 2.27.: Trend in waterbuck population estimates with 95% C.I. intervals.

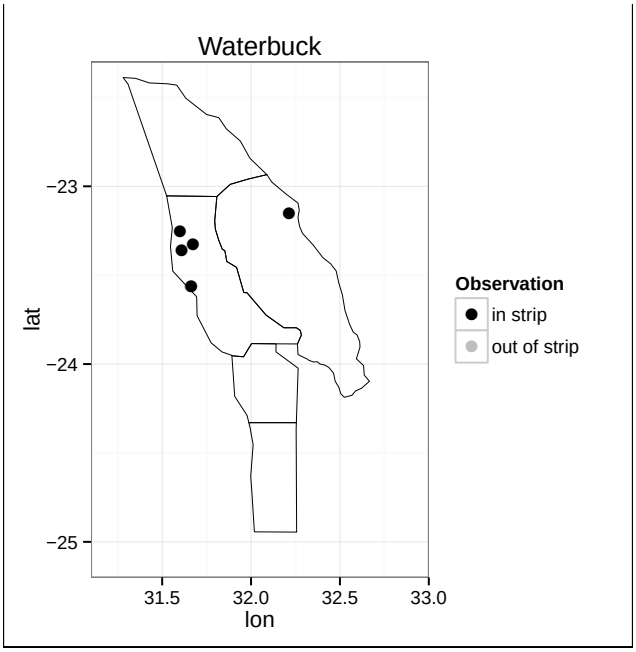

Figure 2.28.: Waterbuck sightings.

Burchell's Zebra *(Equus quagga burchellii)*

Table 2.26.: Population estimates for Zebra in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_north	9	85	7805	9	271	220	0.0266
lim14_west	65	310	7439	136	483	56	0.0954
Total	74	394	15244	150	639	62	0.0330

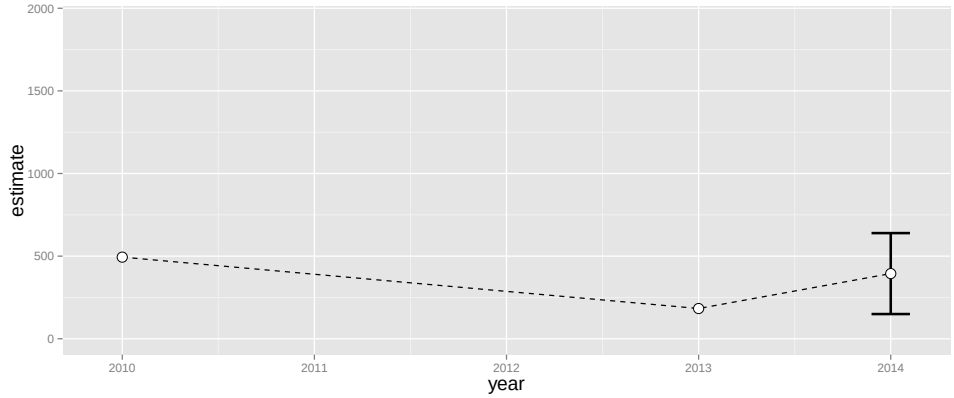

Figure 2.29.: Trend in zebra population estimates with 95% C.I. intervals.

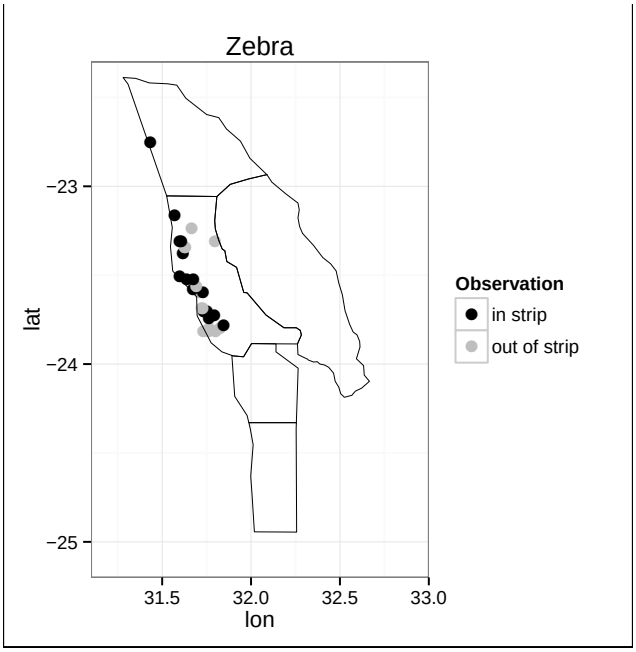

Figure 2.30.: Zebra sightings.

Primates

Two primate species were observed. Observation were made on troops rather than on individuals as these cannot be enumerated from aerial platforms. Hence observation numbers and estimates refer to troops.

Chacma Baboon *(Papio ursinus)*

Table 2.27.: Population estimates for Baboon troops in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_north	1	9	94	1	30	218	0.0030
lim14_west	8	38	218	8	68	78	0.0117
Total	**9**	**48**	**313**	**12**	**83**	**74**	**0.0040**

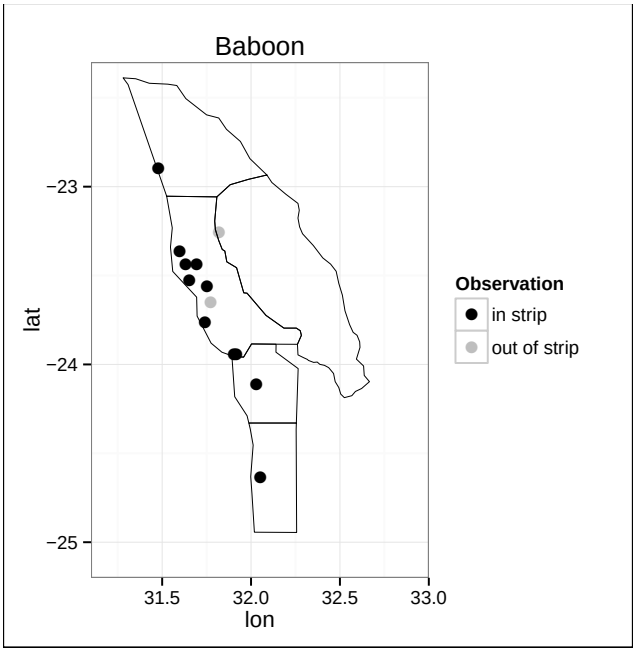

Figure 2.31.: Chacma baboon sightings.

Birds

Southern Ground-hornbill *(Bucorvus leadbeateri)*

Table 2.28.: Population estimates for Ground hornbill in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	19	178	8362	19	364	104	0.0322
lim14_west	7	33	468	7	77	130	0.0103
Total	**26**	**212**	**8830**	**26**	**398**	**88**	**0.0177**

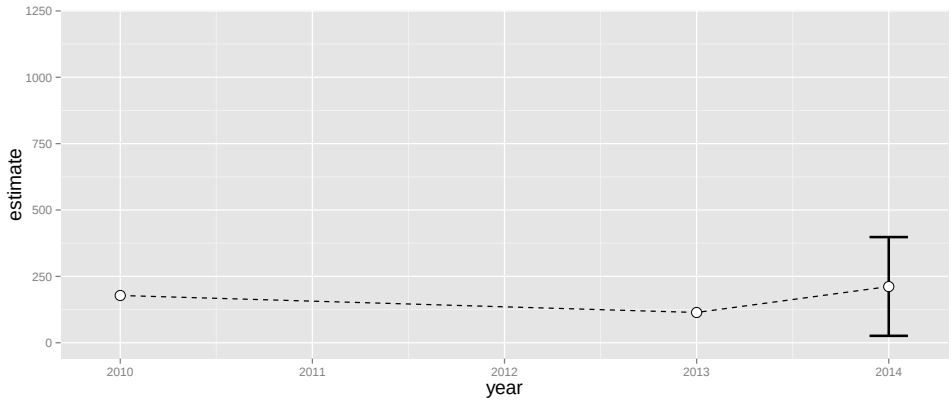

Figure 2.32.: Trends in Southern Ground-hornbill population estimates with 95% C.I. intervals.

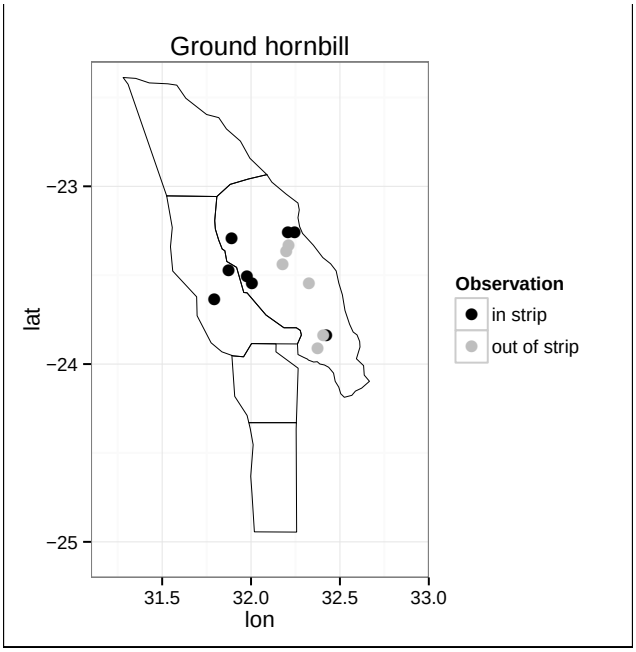

Figure 2.33.: Southern ground hornbill sightings.

Ostrich *(Struthio camelus)*

Table 2.29.: Population estimates for Ostrich in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	8	75	1489	8	154	105	0.0136
lim14_west	31	148	6374	31	308	109	0.0455
Total	**39**	**223**	**7863**	**47**	**399**	**79**	**0.0186**

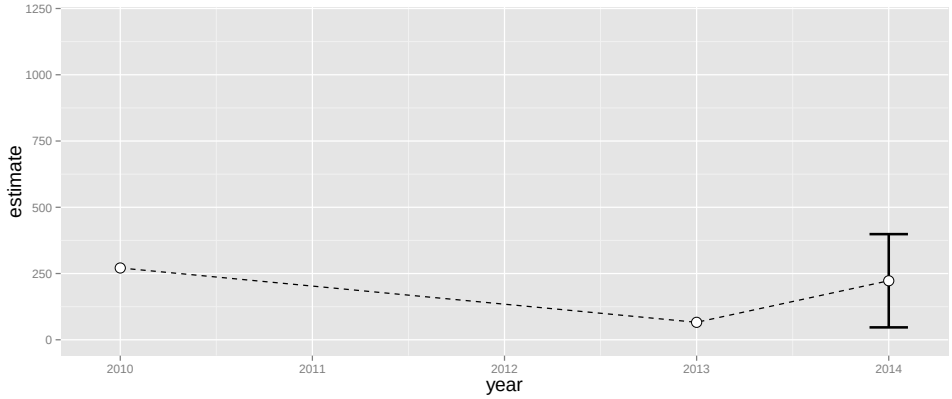

Figure 2.34.: Trend in ostrich population estimates with 95% C.I. intervals.

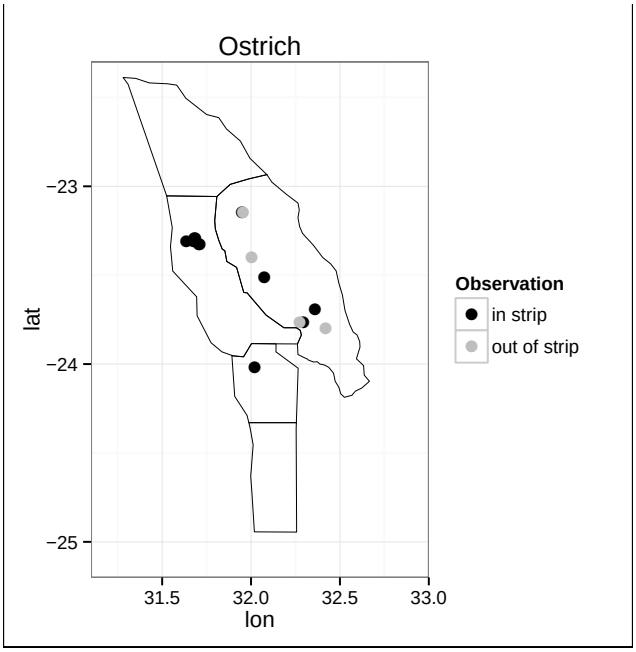

Figure 2.35.: Ostrich sightings.

2.4. Other Observations

Animal carcasses

Table 2.30.: Population estimates for Other carcass in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	11	103	1076	36	170	65	0.0186
lim14_north	3	28	495	3	75	166	0.0089
lim14_west	11	52	206	24	81	55	0.0161
Total	**25**	**184**	**1777**	**100**	**267**	**45**	**0.0154**

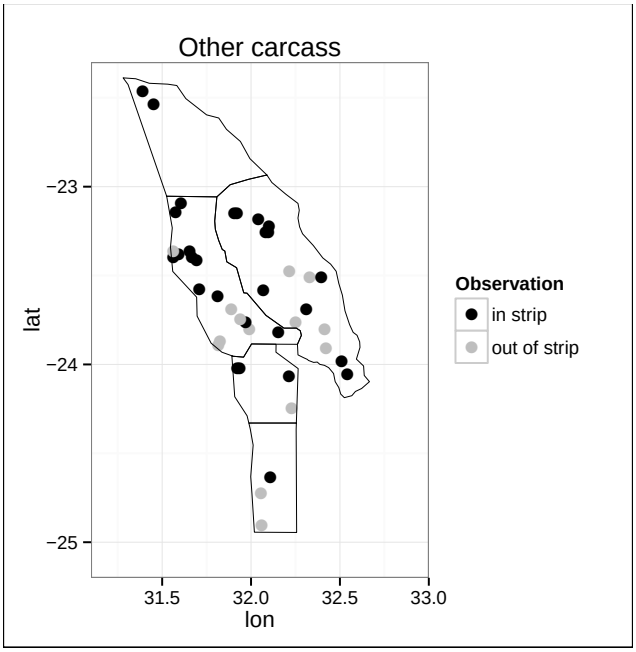

Figure 2.36.: Animal carcass sightings.

Surface water

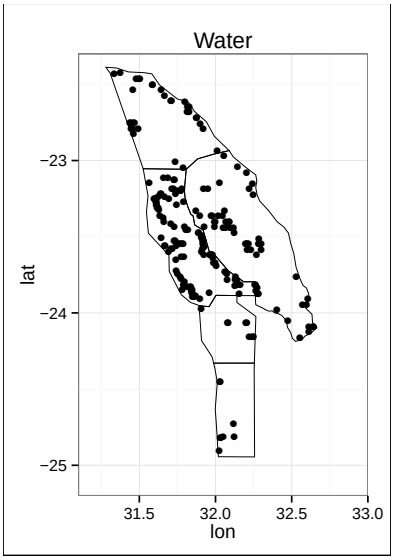

Figure 2.37.: Surface water sightings.

Livestock

Cattle *(Bos taurus)*

Table 2.31.: Population estimates for Cattle in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	2427	22771	18689380	13975	31566	39	4.1147
lim14_north	578	5443	3359290	1576	9310	71	1.7067
lim14_west	1571	7486	2247112	4473	10498	40	2.3048
Total	**4576**	**35699**	**24295782**	**25921**	**45477**	**27**	**2.9822**

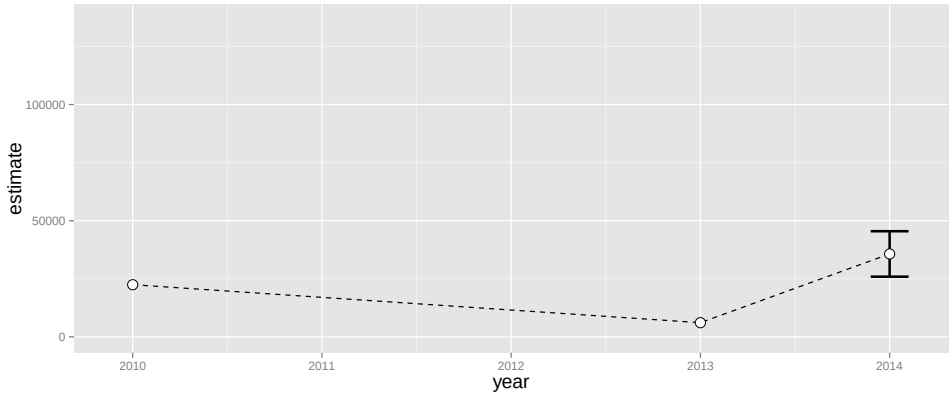

Figure 2.38.: Trend in cattle population estimates with 95% C.I. intervals.

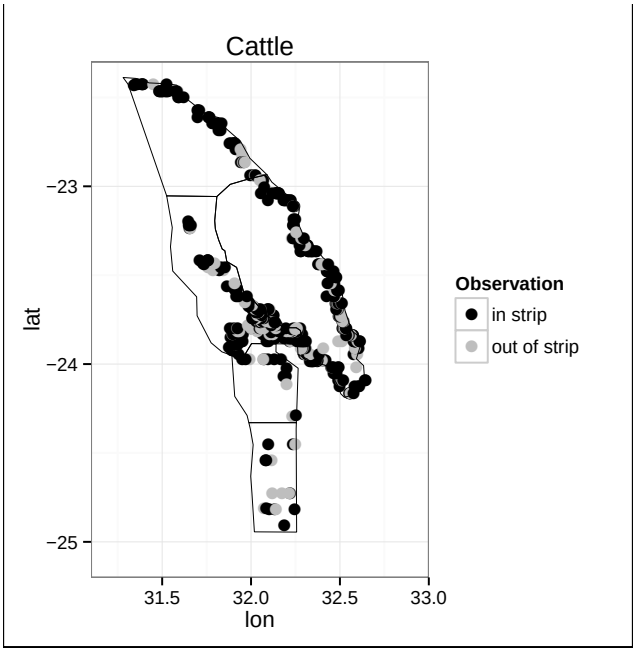

Figure 2.39.: Cattle sightings.

Shoats - Goats & Sheep *(Ovis aries & Capra hircus)*

Table 2.32.: Population estimates for Shoats in the Limpopo.

Stratum	Observed	Estimated	Variance	lower CI	upper CI	PRP	Density
lim14_east	413	3875	1090465	1750	5999	55	0.7002
lim14_north	291	2740	1063379	564	4916	79	0.8592
lim14_west	320	1525	270608	479	2570	69	0.4695
Total	**1024**	**8140**	**2424452**	**5051**	**11229**	**38**	**0.6800**

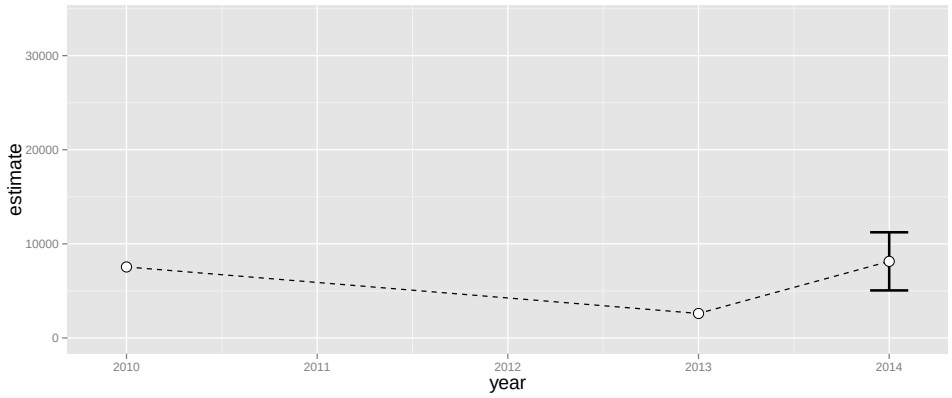

Figure 2.40.: Trend in shoat population estimates with 95% C.I. intervals.

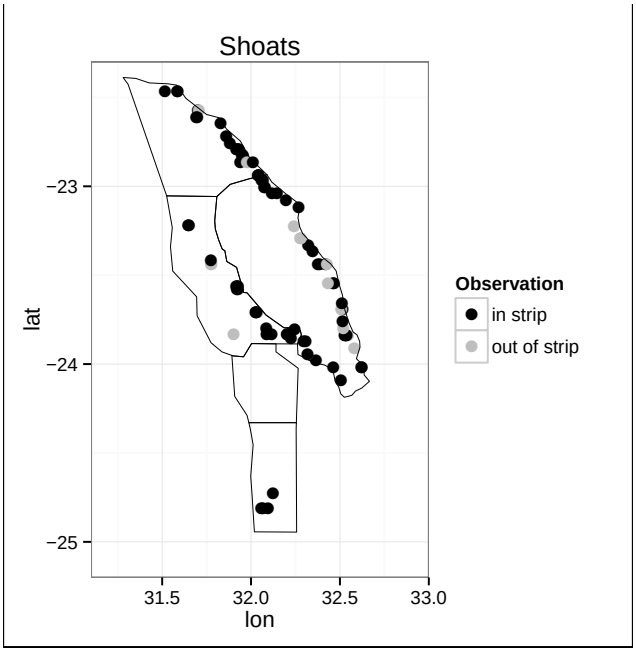

Figure 2.41.: Shoat sightings.

Settlements

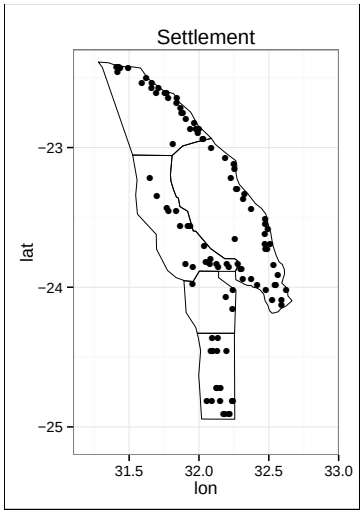

Figure 2.42.: Settlement sightings.

Agriculture

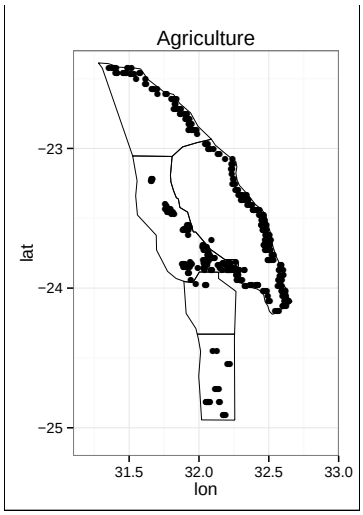

Figure 2.43.: Agricultural activity sightings.

Access

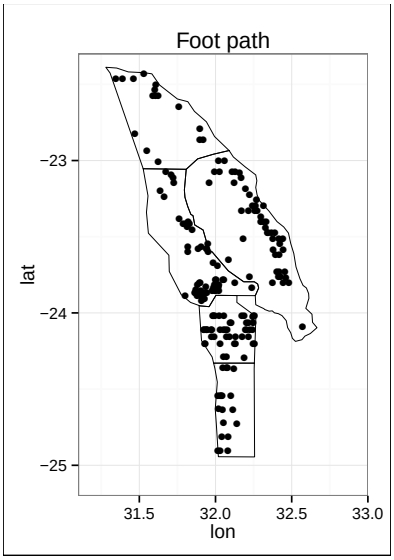

Figure 2.44.: Footpaths sightings.

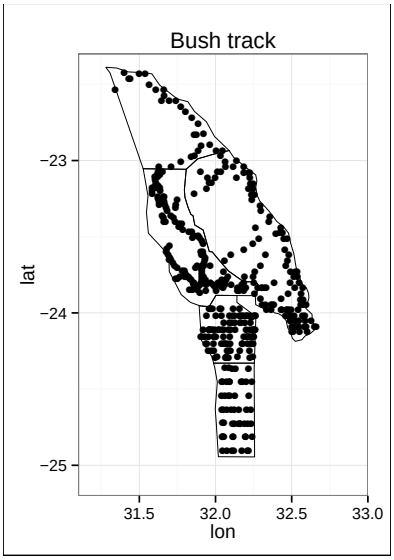

Figure 2.45.: Bush track sightings.

Wood extraction

No large scale wood extraction was recorded during the survey. However, a number of charcoal production sites were observed.

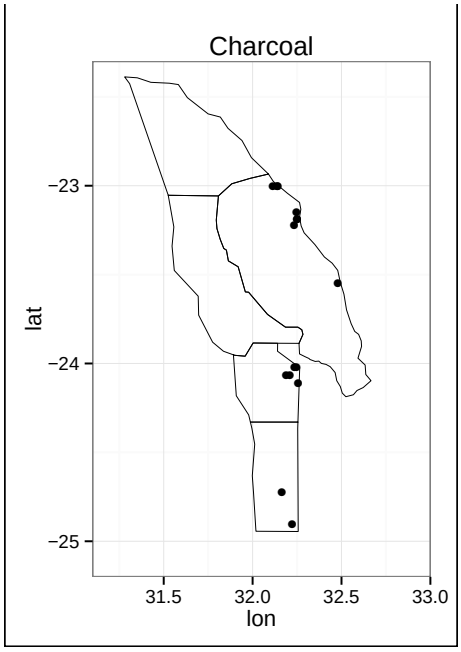

Figure 2.46.: Charcoal production site sightings.

Fishing

No fishing activity was observed inside the park. However, extensive fishing activity was observed on lake Massingir, created by the Massingir dam. This area was not surveyed although partially inside the survey zone for security reasons.

Illigal hunting

Only two hunting camps were observed - one old and one recent/active, although non looked like large operations but rather small shelters maintained for short time periods. Considering the accessibility through the current road and footpath network it is likely that most activity originates out of the settlements within or around the park borders.

3. Discussion and Recommendation

3.1. Discussion

Survey Method Application and Implementation

- Method assumptions: Aerial strip methods have a number of assumptions (listed under Methods Assumptions, page 81). We shortly review each in context of the Limpopo survey implementation and elephants and than expand on some in more detail below.
  Assumption 1 (detection of object within strip is certain): Although likely to hold for live elephants its less certain to assume that this might not be the case for carcasses and categories. Carcass are likely to be underestimated.
  Assumption 2 (objects do not move in relation to observer movement): Elephants reacted to approach and overflight differently. Some of the groups encountered showed directed movement away from the flight path, at 300ft. However, because flight movement is much faster than elephant movement any bias is likely to be small (downward).
  Assumption 3 (object location inside strip is accurate): Observer training, accurate set-up of sampling frame and accurate flight implementation was followed to minimize violations of this assumption.
  Assumption 4 (area covered by the sample is accurate). With the advances in laser technology there has been a gradual shift, away from radar applications, to use the device as the primary tool to measure height above ground (essential in order to estimate strip width). Lasers, however are effected by ground obstructions, such as tree canopy cover, which could introduce an systematic error in estimating strip width. Estimates for both dead and alive would be higher in this case, however, initial investigations (F.Grossmann, tech. documentation) indicate that the effects are small.

- Survey Implementation: The PNL surveys were implemented according to the PAEAS standards. A supporting meta-data presentation is provided in the appendix (Meta-data analysis, page 82. Nevertheless, all aerial strip sampling surveys are susceptible to a wide range of potential bias. Some sources of bias are more significant than others. A discussion on the potential biases effecting this survey implementation and potential effects on the results are outlined in the following bullet points.

- Survey coverage: Although there is some evidence (from ground based observations) that elephants range further east-wards, out of the survey zone and N.P. towards Zinave N.P., the distribution of observations support the assumption that the extend of the survey design spatially captured the population sufficiently. In addition, based on information from the ground, the historic, N.P. focused survey zone was extended to the south in

order to capture possible southward extension of the elephant ranging. PNL is a trans-boundary N.P. and movements of elephants, although somewhat significantly restricted by the presence of an elephant fence along large stretches of the shared border, occurs across this landscape. There is limited data available on extend of this movement and how this effects seasonal distribution patterns. The effects of such movement could potentially have important implication on how to interpret the population estimated and trends of elephants in this zone. The effects of this movement on the elephant population estimate provided here remains unanswered and will require further study. Ideally surveys would have been implemented simultaneously across the entire system in order to capture the population on a landscape level, however this could not be coordinated.
Post-survey assessment for the survey stratification and transect placement support the adequacy of the implemented survey design for PNL.

- Survey timing: The surveys were conducted at the peak of the dry season and hence the best possible conditions for observations. The surveys were conducted within the same time period as historic surveys of the PNL. Timing of the here reported surveys did not coincide with the Kruger surveys (see discussion above).

- Observers: The observers on this survey are probably the most thoroughly trained and experienced Mozambique observer pair available. In addition to recent aerial survey experience they both were park rangers and hence had detailed knowledge of the parks wildlife and identification. In particular their familiarity with some of the more difficult to separate species; kudu, nyala and bushbuck was important. There was no significance difference in the efficiency of observing elephants between the two sides, X^2 (2, N = 198) = 1.7, $p < 0.05$.

- Additional notes on crew configuration: As noted in the methods section, the right Rear Seat Observer (RSO) had to be substituted for two flight days. This was not an ideal situation, however, due to operational challenges and the need to complete the national surveys within the available time frame and resources its was necessary to temporarily "insert" the author of this report into this position. A verification of the correct position was conducted and deemed satisfactory and allowed for the completion of the surveys. Nevertheless, it is recognised that a potential source of bias (or variability) might have been introduced which is not accounted for in the analysis. The potential direction of the bias is unknown. Follow-up analysis could exclude the sessions of the particular observer, however such an approach might come at a cost to the precision of the estimate.

- Flight speed and height: Although largely within the required standards there is a directional pattern with transects running west-wards flown at higher speed. This was due to the wind patterns during the surveys and although the Nat'l PI and pilot were aware of this patterns, flight speeds had to be maintained for pilot comfort and operation safety reasons. The differences are relatively small and hence effects on the observer were assumed to be negligible for the purpose of this analysis. No analytical corrections were made (no transect or sub-sections were removed). Further tests relating observation rates and directionality could be conducted in follow-up analysis.

Although the terrain is not flat, altitude can be maintained as required. The exception of this is in the northern section where two high-power transmission lines cut across the entire survey zone. They are extremely difficult to locate in the undulating terrain - for safety reasons flying height had to be increased to maintain minimum safety along some sections. Overall the effect, however, is limited and should have little effect on the results.

- Detection probability and Nominal Strip width: Detection probabilities within the strip are assumed homogeneous and 100% (everything is seen within the strip; g(stripwidth) = 1) with the applied methods. (see Methods on page 73). However, in the case of the Limpopo zone, with the varying topography and vegetation cover it remains undocumented potential downward bias might be introduced if this assumption does not hold for each of the species sampled. This will be particularly pronounced in species foraging individually or in small groups and cryptic in nature, such as Kudu and Nyala. The survey method used during this survey do not document or account for this heterogeneity and so estimates potentially to have a considerable downward bias for some species. Live elephants estimates are likely to be least affected by this bias, with the implemented nominal strip-width, due to their size and general good observation conditions. However, elephant carcasses, in particular elephant carcasses of category 1 and 2 are likely to be underestimated as these are much more challenging to detect (in particular when in dense vegetation and the absence of vultures) due to the colouration, non-movement etc. This might be one of the most important factors explaining why carcass 1+2 categories do not account for actual losses (i.e. recent carcasses do not balance recent population losses in estimates) during the year, but rather provide an relative index of mortality. The nominal strip width of these surveys was 200 meters ($\pm$ 20 meters) on each side at 300 feet AGL. Although no data was collected concerning detection probabilities of elephants within this strip width, (and hence no attempt was made to correct for any potential bias post-survey), there is support for the assumptions validity; detection conditions were generally good with large areas having low canopy cover, high rates of deciduousness and large areas cleared by burning.

- Operations: The use of Gaza (inside the Park) and Massingir (to the south) allow for efficient access and survey implementation.

- camera use: It was the RSO first exposure to the use of a supporting camera configuration. Overall this application was well picked up and the majority of elephant (live and carcass) observations could be verified post-survey addressing counting and sample errors.

Elephant Population and trends

- Estimates of live elephants: The live elephant population estimate for PNL is 1,081 animals (95% CI: 432 - 1,730). The Percent Relative Precision (PRP) of the estimate was relatively low (60%), however, not unusual for aerial surveys conducted in areas of overall low numbers and uneven distribution. Although methods to earlier surveys deviated (see relevant discussion on page 73), and potential influences of cross border movements not documented, a comparison to earlier surveys is provided. The surveys conducted in 2010 estimated 1,425 individuals with a subsequent helicopter count of 1,014 animals.

The 2013 aerial surveys estimated 603 animals. No variance was provided in the historic reports available to the author and hence no significance test could be derived for the observed differences. Overall the historic estimates are within the here reported estimated confidence intervals. However, although no statistical significant decline can be reported in the live elephant population, high carcass ratios indicate a significant rate of mortality in the survey zone, more than one would expect from natural mortality only.

The surveys confirmed the importance of the southward extension of the elephant range. Considering its relative small size it is nevertheless estimated to contain 10% of the population in the survey zone.

As discussed in the section above, an important unknown parameter in the final estimate of the population size in Limpopo remains the movement and temporal changes in the distribution across the landscape. It is realistic to assume that some individuals cross, either regularly or seasonally between the two areas. Any larger, population level movement patterns could have important effect on the interpretation and understanding of what is happening. The working assumption here is that environmental factors are likely to be the important drivers of movement and distribution, which in turn are often linked to seasonal dynamics. Hence conducting surveys during the same time period across years should minimise any potential effects.

- Estimates of elephant carcasses: The population estimate for elephant carcasses in PNL is 227 animals (95% CI: 134 - 319). Although no fresh carcasses were recorded during the surveys the results indicate high rates of poaching within the last 5 years (assuming that this is the average time to decay for elephant carcasses, more precisely the time they remain available to be observed from a aircraft platform). The over all carcass ratio, that is all categories combined (see more detail concerning this in the relevant Methods sections: page 80 and page **??**) is 16%. In elephant population which do not experience poaching these are expected to be 3% to 5% - so significantly lower than observed in PNL and the extensions. Evidence of poaching in the year preceding the survey was recorded for the western survey zone within the PNL.

- Elephant distribution: Elephant distribution was centred around the western part of PNL, within a strip along the Kruger elephant fence, all the way southward into adjacent wildlife managed areas. Although signs of elephant activity were recorded towards the east, the area seemed to be largely avoided previous to/during the survey period.

- Elephant carcass distribution: Carcass distribution is wide spread across the survey zone. The frequency of carcass observation increased westward - reflecting the current live population distribution and possible underlying poaching dynamics.

- Elephant Status in relation to other Mozambican populations: The PNL elephant population accounts for approximately 11% of Mozambique's remaining elephant population. It is the largest remaining population in the south of the country. With the habitat conditions and connectivity to other PAs within the GLTP landscape still viable, this population has

a potential role in future re-population of currently depleted populations eastwards into Mozambique (Banhine N.P. & Zinave N.P.).

Wildlife Populations and Other Observations

- Cattle (followed by shoats) were the most abundant species observed, with distribution during the peak dry season closely associated to the principal drainage systems in survey zone. More than 75% of total estimated ungulate populations are represented by livestock species in PNL.

- Kudu (*Tragelaphus strepsiceros*) and Nyala (*Tragelaphus angasii*) are the two most abundant wildlife species in the Limpopo N.P., estimated at 1,468 and 1,394 animals respectively. However, the estimate of these two species is likely to be an underestimate (possibly considerable bias) as they are very difficult to detect from a moving aerial platform.

- Not sufficient data points are available for trend analysis. Further, considering the differences in methods some evaluation of the associated bias and errors and their effects on the result will be required. The following comparisons are based on the 2010 surveys, as the 2013 surveys are considered less reliable (Antony Alexander , personal communication, June 18, 2014, see also the Methods Section on page 73).

- Two species were not recorded in earlier surveys; Bush pig (*Potamochoerus larvatus*) and Roan antelope (*Hippotragus equinus*)

- Table 3.1 (page 68) presents a summary of percentage change in the estimates, comparing the 2010 to the 2014 results. Overall estimates between these two periods are different, however, not uni-directional. Further, some patterns seems to emerge where abundant species have a large to very large positive percentage change and less abundant and/or cryptic species a negative, but often less steep decline between the two periods. As discussed elsewhere (Methods, page 73), survey methods were not identical making direct comparison somewhat subjective. Nevertheless, overall the pattern described would be explained, to some extend, by the differences in strip width used - that is more abundant species are likely to be undetected/under-counted with increasing strip width. Less abundant species are equally effected, however, considering the very low numbers of observations the probability of sampling error effecting the estimate increases (chance encounters result in large variation in estimates). Species observed to have a percentage decline are species with very low estimates/populations in general.

Table 3.1.: Population differences of key species estimated between the 2010 and 2014 surveys. Ordered by percentage change.

Species	Pop'l estimate 2014	Pop'l estimate 2010	Pop'l difference	Percentage Change
Elephant	**1081**	**1425**	**344**	**-24.14**
Waterbuck	271	42	229	545.24
Hippo	57	9	48	533.33
Impala	1126	354	772	218.08
Kudu	1468	628	840	133.76
Nyala	1394	913	481	52.68
Buffalo	1339	1035	304	29.37
Ground hornbill	212	178	34	19.10
Ostrich	223	271	-48	-17.71
Zebra	394	494	-100	-20.24
Wildebeest	247	312	-65	-20.83
Giraffe	71	116	-45	-38.79
Bushbuck	9	21	-12	-57.14
Warthog	24	149	-125	-83.89
Sable	14	119	-105	-88.24
Cattle	35699	22456	13243	58.97
Shoats	8140	7545	595	7.88

3.2. Recommendations

Elephant Conservation

1. The Limpopo elephant population has been under considerable poaching pressure over the last 2-5 years and continues to be a major threat to the population, although recent poaching activity was limited to two recent carcasses. Observed distribution patterns along the Kruger border might indicate that animals feel safer on that side (due to the numbers of patrol posts). Potentially using the described distribution patterns for directing patrolling as well as the creation of Intensive Protection Zones (IPZ) might support current management strategies, if not in place already. Further, GPS collaring and monitoring of individuals might provide additional information on movement patterns and habitat use which could inform both protection strategies as well as future surveys.

2. Mozambique elephant population has experienced a massive loss over the last five years, loosing approximately half of its elephant across the entire range. The high level goal set in the Strategy and Action Plan for the Conservation and Management of Elephants in Mozambique 2010 - 2015 [6] have not been achieved, calling for detailed reflection of the challenges and re-prioritizing strategies moving forward.

Survey Design and Methods

3. Further research concerning the detection probabilities for elephant carcasses across different categories and monitoring decay and life span of the different carcass categories is required to improve current modelling of elephant populations based on aerial survey data. This is specifically important in open systems were movements of elephants across the landscape (and out of the survey zone) can limit the value of population estimates and trends and mask the identification of possible population sinks.

4. Future research and surveys should also address the extend and effects of the temporal dynamics of elephant abundance across the landscape on survey timing. GPS collaring and monitoring of individuals might provide additional information on movement patterns and habitat use which could inform both protection strategies as well as future surveys.

5. Strip width and height: In order to reduce the bias introduced by heterogeneous detection probabilities (especially for the more cryptic species) it might be useful to experiment with methods which can capture and document such variability - such as line transects or double observer configuration. Understanding these biases will add more utility and statistical power to the monitoring outputs.

6. Survey zone and stratification: The presented stratification seems appropriate and we recommend this to be retained in future surveys. The most southerly zone of the extension could be dropped and an increase sampling intensity implemented in the remaining extension.

Acknowledgements

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A. Appendices

A.1. Methods

Although overall survey design and methods were guided using estimate and distribution outputs from previous surveys we decided to implement some changes to the stratification, effort allocation and methods. These changes will have an effect on comparability of the results, however, the overriding objective of the surveys was to implement a survey design that 1) provide sufficiently robust and precise survey estimates for expected numbers and distribution, 2) adhere to the minimum standard requirements as outlined in the PAEAS document [8] and 3) address current management questions. A concern regarding earlier implementation was the very wide strip width (800 meters on each side), four times the maximum recommend width, the lack of fixed streamers and in flight calibration. A short description and assessment of changes in provided in the following:

- **Stratification**:No stratification was used in earlier surveys. Although adding stratification should have no effect in the overall estimate it can improve precision and allows for sample effort to be varied according to expected density. Distributions have a marked spatial gradient, with higher concentration along the Kruger National Park border to the west.

- **Samples**:Although earlier surveys seemed to have used four distance bins using markers on the windows (0-100m,100-200m,200-300m,300-400m) on each side, analysis was based on the pooled strip width. This is twice the width of the nominal strip width targeted during this survey. Detection rates decrease steadily from the centre line beyond 200 meters for most species and hence we would expect earlier surveys to have a significant downward bias.

- **Flight parameters**: Flight height in earlier surveys was 250 *ft* above the ground, 50 *ft* lower than the target altitude of these surveys. The effects of height above ground on the detection process are not well documented in published literature, however, they are likely to have an effect on some species detection (for example, kudu are more likely to move -and hence detected - at lower altitudes). Height also has an effect on the displacement of the start of the strip - the higher one flies the further the strip from the centre line - which in turn effects detection distances.

Aerial survey are complex to implement and hence a number of potential sources of bias effecting the final estimate exists. The documentation of the methods and implementation is a crucial part of the analysis and evaluation of results. This is provided in this and the following sections of this appendix. The first section provides a detailed description of the methodology followed by a meta-data presentation of the implemented survey in relation to target standards.

A discussion on the effect of potential bias identified for this particular survey is provided in the Discussion chapter (page 63).

A.1.1. Survey priorities and zone delineation

The core priority survey zone (global area defining spatial limits of population estimates) was defined by the PNL boundaries, with an additional $10km$ buffer along its eastern extend in order to fully cover the major river system that defines the PA border. After further discussion in Limpopo an extension to the survey zone was added to investigate reports of elephant occurring along a thin strip outside, to the south of the National Park. PNL has been systematically surveyed using fixed wing aircraft on three occasions - 2007, 2010 and 2013 [12],[10]. In addition an extensive helicopter survey was conducted in 2010 [11]. Surveys have been timed to coincide with the late dry season (September - October). The bibliography contains a full list of all surveys conducted to date.

A.1.2. Sampling design and parameters

The following section provides the details of the sampling design and nominal parameters applied during the survey implementation:

- **Survey zone stratification**: The survey zone was divided into five strata - 3 within the PNL and two the south of the park. The strata inside the park are based on general patterns of animal distributions and key drainage systems. The two strata outside, to the south where based on available resources and remaining time. They were more exploratory in nature as only anecdotal information existed.

- **Sample method**: Belt transects placed systematically across the survey strata (commonly referred to as Systematic Reconnaissance Flight (S.R.F.) in the African survey literature) were used as samplers. Samplers were placed to cover the entire width of the strata. Sampling was done without replacement.

- **Sample design**: Transects samples were placed perpendicular to drainage systems (as was in previous surveys) in order to reduce sample variability. All samples were run in an east-west direction. Samples were separated by 2 - 4 km with PNL and 5- 10 km for the southern extension. The initial placement of the first transect had a random starting point. The sample design was developed in DISTANCE software [13].

- **Search rate**: The target search rate was $< 1.5\ km^2$ per minute.

- **Strip width**: The target strip width was 200 meters either side of the aircraft. Displacement of the strip from the centreline was minimised as far as possible.

- **Flight parameters (height,speed)**: The target speed was 90 knots and the target flight height was 300 ft above ground level (AGL).

Table A.1.: Strata design meta data for the Limpopo 2014 surveys.

strata	strataid	globalid	area	spacing	base
Limp. east	lim14_east	lim1401	5534	4000	139
Limp. west	lim14_west	lim1401	3248	2000	98
Limp. north	lim14_north	lim1401	3189	4000	75
Limp. ext. 1	lim14_extsouth1	lim1401	1716	10000	68
Limp. ext.	lim14_extsouth	lim1401	1524	5000	48

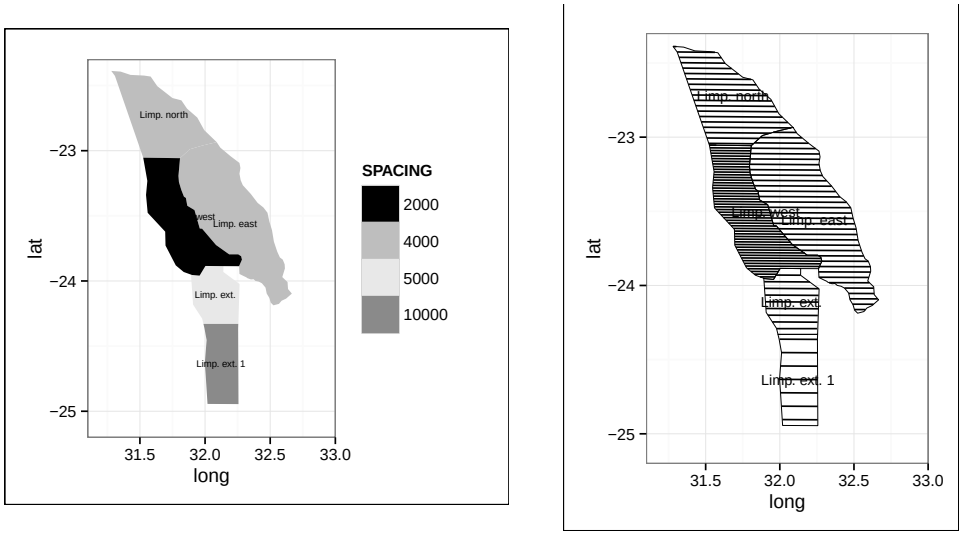

Figure A.1.: Stratification, effort allocation and sample placement.

A.1.3. Instrumentation

The following list of instrumentation was used during the surveys:

- **Aerial Platform**: The survey was conducted using a Cessna Skylane (C-182) (Registration: ZS-IWM).
- **Horizontal Navigation**: Survey designs were flown using a aviation grade Global Positioning System (GPS) (GarminMap 296). The survey design was split into flight sessions and uploaded to the device daily. In order to join and reference the various data streams all instrument internal clocks were synchronised based on the GPS provided time, in Coordinated Universal Time (UTC) units.
- **Vertical navigation**: A laser measurement device was attached to the outside of the airframe (ILM-150, Renishaw). The device collected 5-10 readings a second which were averaged to one reading per second for further analysis. Each measurement was annotated with a GPS location and a time stamp.
- **Data input and logging**: Observations called out by the RSO was entered during the survey by the Front Seat Observer (FSO) using a Nexus tablet and a custom, Java based software [1]. Observations entered were annotated with GPS coordinates and a UNIX time stamp. Although location fixes should generally be quite accurate when correct procedures are followed - user delay can cause displacements. Captured locations cannot be used to verify if locations were in or out of the strip. Data streams from the GPS, set at a 1 second interval, and the laser were logged using a logger (Antilog, Anticyclone Systems) or a custom application developed by Vulcan Inc.
- **Cameras**: Two cameras were securely fixed (using Delkin Fat Gecko suction device) to the left and right rear positions and calibrated to the observer field of sight. The cameras used were Canon EOS 100D, with 18.0 effective megapixel using Canon a 20mm f/2.8 wide-angle Lens (2509A003). Cameras were operated using a remote trigger (Vello RS-C1II Wired Remote Switch). The FSO had an additional camera to record important sightings.
- **Audio**: Audio was recorded at two levels; 1) the entire communication within the aircraft was recorded through the audio panel using a patch cord (Aircraft Audio Patchcord) and 2) a separate audio recorder for each observer (Sony ICD-UX533 Digital Flash Voice Recorder). This provided redundancy in case of failure or user error and was used to counter check the FSO data inputs post-survey.

[1] SurveyMonkey, D.Potgieter, 2014

A.1.4. Observation Protocol

Survey Team

Team 1 - Cessna C182

- FSO: Grossmann, F. (WCS)
- Right RSO: Bendzane, E. (ANAC/PPF Limpopo)
- Left RSO: Maluleque, G. (ANAC/PPF Limpopo)
- Pilot: Parker, N.

Training of Observers and Pilots

Training followed general recommendations provided by PAEAS [8] and Dirchl et al. (1981)[2]. This included a series of test, including eye sight, species identification and equipment use. Once the final team was selected further in flight training was conducted. A particular focus was concerning the standardized and consistent classification of elephant carcass categories and sexing of elephants from the air. Pilots were provided with guidance on survey flying techniques including the importance of precision flying in vertical and horizontal navigation.
The principal team involved in the PNL was selected from Limpopo National Park ranger staff because of the substantial aerial survey experience they brought to the team (total RSO time: 30 - 60 hours). These two observers are currently the most highly trained and experienced RSO's. in Mozambique. The front seat observer for the surveys was the principal investigator and author of the report. The FSO for the extension was David Chambal.

Elephant Group Categorization

The following was used for categorization of elephant sightings:

- **bull groups**: Groups which exclusively contained bulls, or bulls with smaller individuals of unknown (presumed male) category,
- **family groups**: All female groups and/or groups containing calves, on occasion might contain bulls,
- **uncategorised**: These were groups of uncertain sex and which were not rechecked for verification. For analysis purposes these were grouped with family groups.

Carcass Categories

Carcasses categories are based on the categories outlined in the MIKE Aerial Survey Standards [1]. Although carcasses categories are often used as an age classification, this is not strictly valid. Carcasses categories are exclusively identified by a set of indicators describing the physical condition of the carcass. These indicators are effected by a number of environmental variables

(climate, rainfall, vegetation etc.) and density of scavengers. As a result decay rates and transition times from one category to the next can be very substantially, within the survey zone and across different seasons. This survey used the following set of indicators, based on the above reference. Underlined indicators are non-category overlapping indicators and hence were used to positively identify between the four categories. Non underlined are not exclusive indicators to a category.

- **Carcass Category 1**: Fresh (<1 month). a) still has flesh, b) ground moist from body fluids, b) bloated and rounded, c) vultures present and fresh, recent scavenger signs
- **Carcass Category 2**: Recent (< year). a) rot patch, b) skin still present (but not necessary), c) skeleton not scattered and large majority of bones present,
- **Carcass Category 3**: Old (> 1 year). a) clean bones, b) bones not scattered, c) skin absent, d) vegetation regrowth in rot patch but possibly still visible,
- **Carcass Category 4**: Very Old (beyond class 3). a) only partial skeleton, b) darker colouration, c) bones widely scattered.

Other Observations

- **Other Wildlife and Livestock**: All observation of mammals above 15kg were recorded, including livestock. Baboons were enumerated by troops, rather than individuals. In addition observations of ground-hornbill, ostrich and vulture species were also included. The objective was to estimate population abundance.
- **Human activity**: All observation of human activity was recorded. The objective was to map and establish encounter rates only.

A.1.5. Data Handling Protocol

Data entry, cleaning and preparation followed a number of steps in order to reduce and eliminate any user, transcription and input errors. These are shortly outline below.

- **Observations**:Digital data entries from the FSO tablet were cross-checked with the audio records of the two RSO and corrected were necessary.
- **Photos**: All images were geocoded (GPsync) using the time stamp. All images taken were viewed and important images selected and tagged. Observations of animal groups above 9 animals were selected and counted. Photo counts were classed into two categories (high quality = clear view, focused, complete / low quality = obstructed, not clear) scoring quality and completeness. Observer counts were corrected according to the following data base rules: 1) if image was categorised as good the image count was used, 2) if the image was categorised as poor the observer count was used, however, with the exception of, 3) if image was scored poor but the image count was higher than the image count was used. All elephant observations as well as the majority of carcasses were rechecked on photos.

- **Data handling and analysis**: All data handling, analysis and plotting was conducted in R[9] using a customized software library and work flow.

A.1.6. Analysis

The analysis of population estimates and their precision was based on the ratio method for unequal-sized units [5]. This approach is commonly referred to as the Jolly II method and is calculated as follows:

Object density (ratio estimate):

$$R = \frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} z_i} \tag{A.1}$$

Population estimate:

$$\hat{Y} = Z \times R \tag{A.2}$$

Population variance:

$$Var_{\hat{Y}} = \frac{N(N-n)}{n} \times (S_y^2 - 2 \times R \times S_{zy} \times R^2 \times S_z^2) \tag{A.3}$$

where:

Z = survey zone (stratum) area

N = number of possible samples in stratum ($N = n \times Z / \sum z$)

n = number of samples taken

z_i = area of sample i

$\hat{Y}$ = population estimate

y_i = number of objects counted in sample i

S_y^2 = variance of objects seen by sample y

S_z^2 = variance of sample areas z

S_{zy} = covariance between objects counted and sample area

Global estimates (for the entire survey zone) where obtained by summing stratum estimates and their population variance. The standard error was obtained by taking the square root of the variance. The 95% confidence limits of the population estimate where derived by $\hat{Y} \pm t$, where t is the Student's t distribution for a two-tailed probability of 0.05 and $n-1$ degrees of freedom.

Carcass ratio

The elephant carcass ratio was calculated following Douglas-Hamilton and Burrill (1991)[3]. Carcass ratios provide and index of elephant mortality, which is the sum of natural and anthropogenic induced deaths, in the population. It is reported as a percentage and is derived as follows:

$$carcass\ ratio = \frac{all\ carcasses}{live\ elephants + all\ carcasses} \tag{A.4}$$

The ratio can also be applied to category 1 and 2 (fresh and recent carcasses) to derive the mortality index for the population for the year preceding the surveys [4]. The 1+2 carcass ratio is derived as follows:

$$1+2\ carcass\ ratio = \frac{Cat.1\ carcasses + Cat.2\ carcasses}{live\ elephants + Cat.1\ carcasses + Cat.2\ carcasses} \tag{A.5}$$

A.1.7. Method Assumptions

The validity of strip survey methods are based on a number of assumptions:

1. Objects within the strip are always detected (no detection or availability bias effecting the observation process),
2. objects do not move in relation to observer movement, especially responsive movement before detection is problematic,
3. placement of object location inside strip is accurate,
4. measurement of the area covered by the sample is accurate and
5. enumeration of objects within the strip is accurate.

A.2. Survey Meta-data Presentation

The following section presents meta data quantifying the implemented flight and observer parameters and allows for the assessment of how well the standards were maintained. Specific issues pertaining to any observed deviations are presented in the Discussion (page 63), under the sub-heading "survey implementations".

A.2.1. Survey Implementation

Figure A.2.1 presents the implementation of the survey design showing the flown GPS tracklog, the survey strata and the survey zone. Further tabulated detail for each of the samples (transects) is provided below.

A.2.2. Calibration of Strip width and Camera

Belt (strip) transects were used as samplers. However, defining the width of these samplers from aerial platforms is challenging as static placement of streamers (rods attached to the aircraft defining the strip) results in variation width with 1) height of the aircraft, 2) line of sight with the changes in position of the observer and 3) the bank, yaw and roll of the aircraft. Further, 1) errors in set-up of the streamers and the correct positioning of the observer and 2) mismatches between the field of sight of the observers and the fixed camera can results in signification bias in the final data set and derived results. In order to minimise any potential errors the following procedures were followed:

- The set up of the streamers for delineating the survey belt was for each of the observers (nominal strip width was 200 meters) was conducted in Massingir on the 24th of September for the principal RSO team.
- Due to sudden and unforeseen circumstances the right RSO had to replaced by for two of the survey days (1st and 2nd October). This position was filled by the survey FSO (first author of report) for this period of time. A trained replacement for the FSO was with the survey team. In order to test how well the replacement right RSO could observe the defined strip-width a further test calibration flight was performed on the 3rd based out of Gaza. The results [0.7651x - 15.863, R^2 = 0.93] indicate that the replacement observer could maintain position as required.
- Twenty overflight were conducted and counts taken for each side, in addition to height (taken from the laser altimeter). The target regression coefficient was $r = 0.90$ and a y intercept of ± 20 meters. The results for the two observers are provided in figure A.3.
- In addition the strip width calibration for the observer position the cameras were also checked to ascertain that the observer field of view was equivalent to the camera field of view. This is important as images were used to check for counting bias as well as verification of inclusion of observations into the sample. The results of the relationship between the observer and camera counts are shown in the lower section of figure A.3.

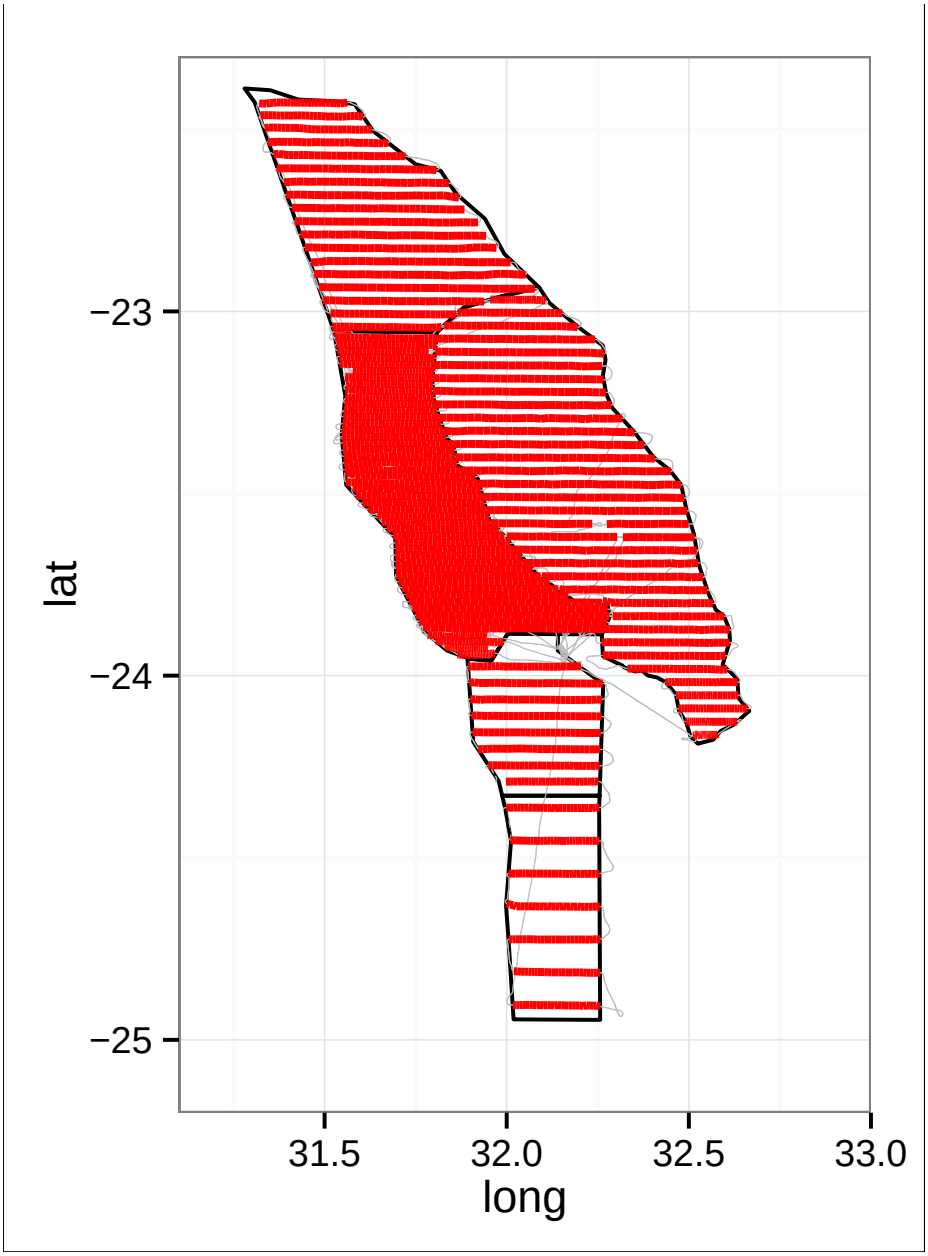

Figure A.2.: GPS track-log of implemented on-transect effort (in red).

- **Calibration results**: Although the final calibration did not achieve the desired regression coefficient of $r = 0.90$, the results were very close and deemed satisfactory. The correctness of the set-up was confirmed by the camera regressions to height, with both exceeding the desired target and providing close to equivalent strip-width at nominal altitude. Camera and observer counts correlated well and as required for the correction method.

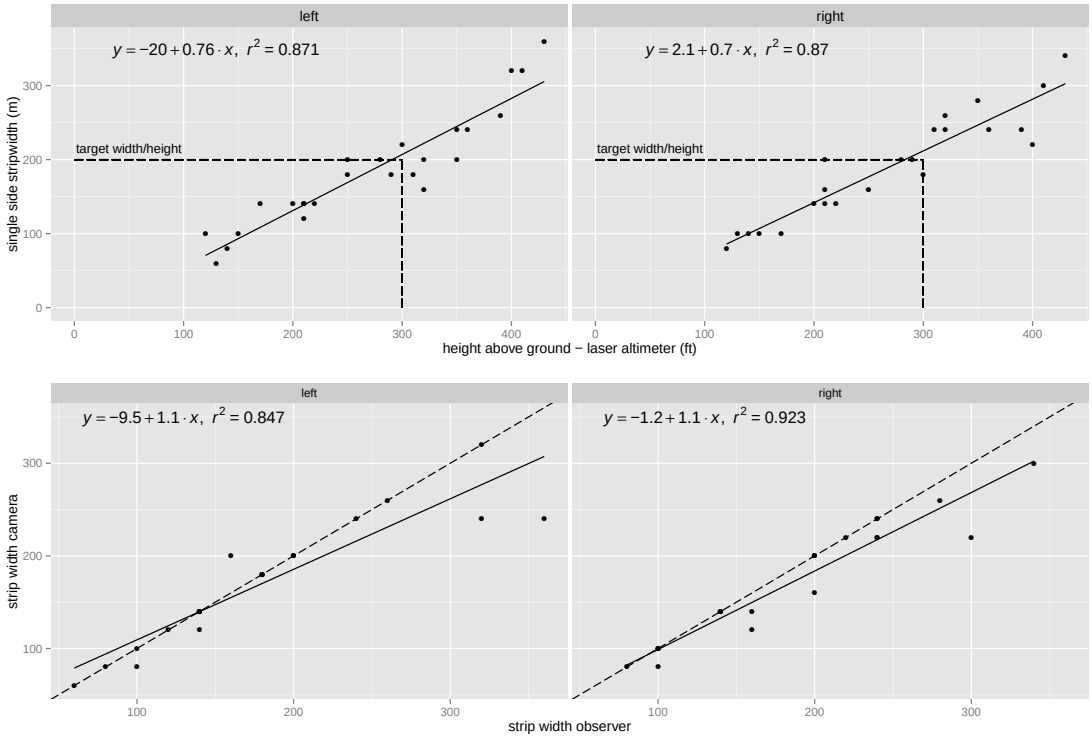

Figure A.3.: Calibration for each observer and respective camera

A.2.3. Observer Efficiency

The numbers of individuals and groups recorded by each of the two RSO were compared in order to determine observer efficiency. The assumption is that observations should be similar on both sides, with comparable levels of detection probability and animal distribution. If real differences of observer efficiency exist they should be particular pronounced in common species. Differences in counts for rarer species are difficult to identify as detection contains a larger element of chance. The results presented below do not give an indication which observer counted more accurately. The photo counts provide this correction. For each of the observed species the total number of individuals and the total number of groups were tallied, across all transects. This number was than compared with the expected number of observations each observer was expected to see, following methods in [4] and calculated as follows:

$$ExpectedNumber = \frac{Total\ Number\ \times\ Observer's\ Strip\ Width}{Total\ Strip\ Width\ for\ both\ Observers} \tag{A.6}$$

where:

Expected Number = the expected number of groups/individuals each observer was expected to see if detection probabilities were equal,

Total Number = the total number of groups / individuals counted for each of the species by both observers,

Observers Strip Width = the strip width (m) for each of the observer positions individually at the nominal height,

Strip Width for both Observers = the combined strip width for both observer positions.

A Chi-square one sample statistical test with 1 degree of freedom was used to compare the observed to the expected of groups and individuals for each of the observer positions. The null hypothesis that observer efficiency is equal is rejected if the p-value of the Chi-squared test statistics is less $P < 0.05$. The test requires a minimum observed count of > 5. The results of the analysis of differences in observer efficiency in spotting and counting animal groups and individuals is provided in the respective tables below.

Table A.2.: Observer efficientcy and chi-square results of groups detected by species

Species	Grp. Obs. Left	Grp. Obs. Right	Total Grp.	Grp. Exp. Left	Grp. Exp. Right	Chi-square Grp	p
Baboon (troops)	8.00	3.00	11.00	5.44	5.56		
Buffalo	13.00	15.00	28.00	13.84	14.16	0.1	ns
Bushbuck	0.00	2.00	2.00				
Bushpig	6.00	2.00	8.00	3.95	4.05		
Cattle	177.00	176.00	353.00	174.47	178.53	0.1	ns
Elephant	17.00	11.00	28.00	13.84	14.16	1.4	ns
Elephant bulls	6.00	2.00	8.00	3.95	4.05		
Elephant carcass	17.00	16.00	33.00	16.31	16.69	0.1	ns
Elephant carcass 1 and 2	1.00	0.00	1.00				
Elephant carcass 3 and 4	16.00	16.00	32.00	15.82	16.18	0	ns
Elephant cows	11.00	9.00	20.00	9.88	10.12	0.2	ns
Giraffe	5.00	5.00	10.00	4.94	5.06	0	ns
Ground hornbill	5.00	3.00	8.00	3.95	4.05		
Hippo	1.00	2.00	3.00	1.48	1.52		
Impala	19.00	5.00	24.00	11.86	12.14	8.5	0.004
Kudu	37.00	37.00	74.00	36.57	37.43	0	ns
Nyala	54.00	32.00	86.00	42.5	43.5	6.1	0.013
Old elephant carcass 3	8.00	6.00	14.00	6.92	7.08	0.3	ns
Old elephant carcass 4	8.00	10.00	18.00	8.9	9.1	0.2	ns
Ostrich	5.00	6.00	11.00	5.44	5.56	0.1	ns
Other carcass	21.00	7.00	28.00	13.84	14.16	7.3	0.007
Recent elephant carcass	1.00	0.00	1.00				
Roan	0.00	1.00	1.00				
Sable	0.00	2.00	2.00				
Shoats	32.00	41.00	73.00	36.08	36.92	0.9	ns
Small antelope	22.00	11.00	33.00	16.31	16.69	3.9	0.048
Vervet monkey (troops)	2.00	1.00	3.00	1.48	1.52		
Warthog	1.00	3.00	4.00	1.98	2.02		
Waterbuck	3.00	2.00	5.00	2.47	2.53		
Wildebeest	4.00	5.00	9.00	4.45	4.55		
Zebra	9.00	7.00	16.00	7.91	8.09	0.3	ns

Table A.3.: Observer efficientcy and chi-square results of individuals detected by species

Species	Ind. Obs. Left	Ind. Obs. Right	Total Ind.	Ind. Exp. Left	Ind. Exp. Right	Chi-square Ind	p
Baboon (trrops)	8.00	3.00	11.00	5.44	5.56		
Buffalo	117.00	117.00	234.00	115.65	118.35	0	ns
Bushbuck	0.00	2.00	2.00				
Bushpig	19.00	3.00	22.00	10.87	11.13		
Cattle	2178.00	2683.00	4861.00	2402.51	2458.49	41.5	0.000
Elephant	107.00	91.00	198.00	97.86	100.14	1.7	ns
Elephant bulls	21.00	9.00	30.00	14.83	15.17	5.1	0.024
Elephant carcass	18.00	17.00	35.00	17.3	17.7	0.1	ns
Elephant carcass 1 and 2	2.00	0.00	2.00				
Elephant carcass 3 and 4	16.00	17.00	33.00	16.31	16.69	0	ns
Elephant cows	86.00	82.00	168.00	83.03	84.97	0.2	ns
Giraffe	8.00	10.00	18.00	8.9	9.1	0.2	ns
Ground hornbill	17.00	9.00	26.00	12.85	13.15	2.6	ns
Hippo	4.00	8.00	12.00	5.93	6.07		
Impala	159.00	45.00	204.00	100.83	103.17	66.4	0.000
Kudu	128.00	121.00	249.00	123.07	125.93	0.4	ns
Nyala	121.00	86.00	207.00	102.31	104.69	6.8	0.009
Old elephant carcass 3	8.00	7.00	15.00	7.41	7.59	0.1	ns
Old elephant carcass 4	8.00	10.00	18.00	8.9	9.1	0.2	ns
Ostrich	31.00	9.00	40.00	19.77	20.23	12.6	0.000
Other carcass	22.00	7.00	29.00	14.33	14.67	8.1	0.004
Recent elephant carcass	2.00	0.00	2.00				
Roan	0.00	1.00	1.00				
Sable	0.00	3.00	3.00				
Shoats	463.00	581.00	1044.00	515.99	528.01	10.8	0.001
Small antelope	30.00	11.00	41.00	20.26	20.74	9.2	0.002
Vervet monkey (troops)	2.00	1.00	3.00	1.48	1.52		
Warthog	3.00	5.00	8.00	3.95	4.05		
Waterbuck	46.00	10.00	56.00	27.68	28.32	24	0.000
Wildebeest	29.00	20.00	49.00	24.22	24.78	1.9	ns
Zebra	42.00	32.00	74.00	36.57	37.43	1.6	ns

A.2.4. Counting Bias

The table below provides a summary of the photo correction and counting bias. The ratio is derived by comparing observer raw counts by post-survey image counts. It should be noted that this ratio is provided for all observation/image pairings, however, it not likely that the observer count bias is independent of groups size. That is, the larger the group size the larger the expected count bias. This is evident in the analysis of livestock counts (Figures A.2.4 and A.2.4)
Counts were only verified when group size was estimated above 9 individuals.

Species	Frequency of Observation	Frequency Images taken	Frequency Usable Images	Percentage Usable	Animals Observer Counted	Animals Image Count	Correction Factor[a]
Buffalo	5	4	3	60	100	89	0.89
Cattle	156	140	124	79	2936	3268	1.11
Elephant	6	6	6	100	141	109	0.77
Elephant cows	6	6	6	100	141	109	0.77
Ostrich	1	1	1	100	11	11	1.00
Shoats	40	31	21	52	428	491	1.15
Wildebeest	1	1	1	100	14	15	1.07

[a] derived by *image count* divided by *observed count*. Fraction close to 1 indicate equal counts between methods, smaller than 1 indicates upward observer bias and larger than 1 indicate downward observer bias).

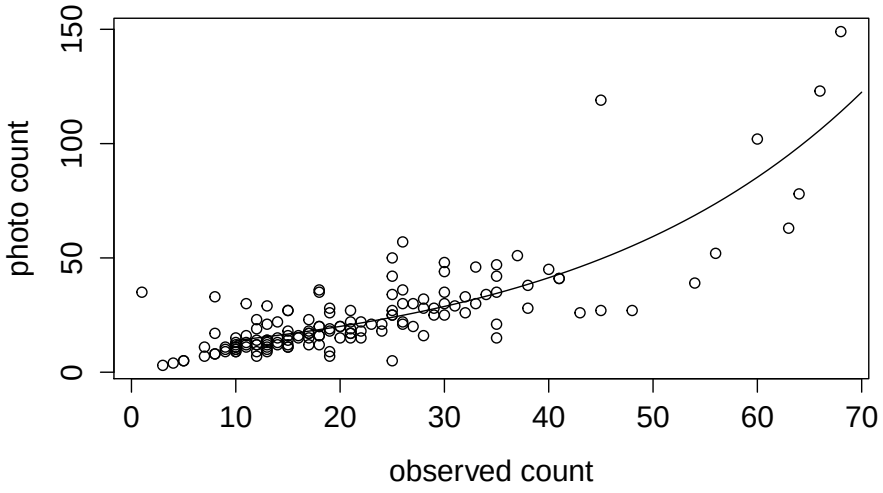

Figure A.4.: Comparison of observer count ("counted number") by photo count (actual number) for cattle.

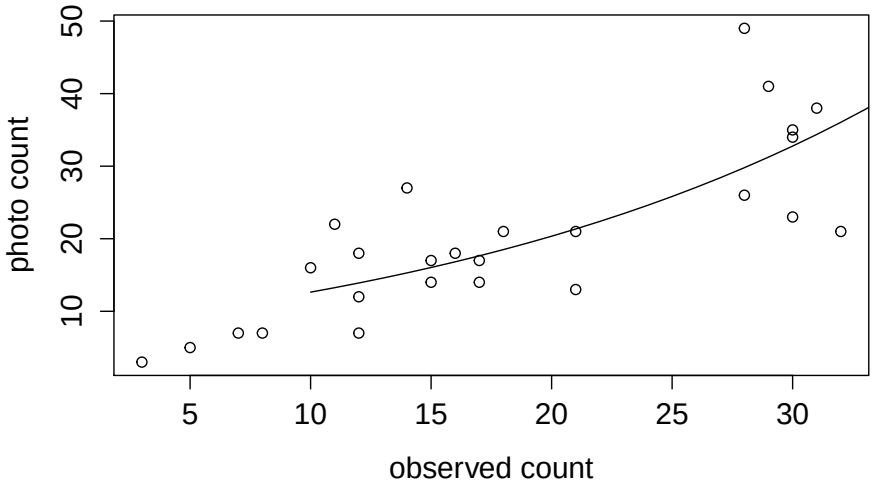

Figure A.5.: Comparison of observer count ("counted number") by photo count (actual number) for shoats.

A.2.5. Height Above Ground and Ground Speed

The following graphs provide a summary representation of all ground speed (knots) and height above ground (feet) measurements for each of the transects. The mean value is represented as a white point. Standard deviation for all measurements taken for each transect are shown in red bars. The target value is indicated by a solid line. The dashed lines indicate the following: for the aircraft speed they delineate the target minimum (86.3 knots) and maximum (97.1 knots) speeds, for the altitude above ground level they represent 1 standard deviation from 300 feet. A tabular summary is provided in table A.2.6 and A.2.7.

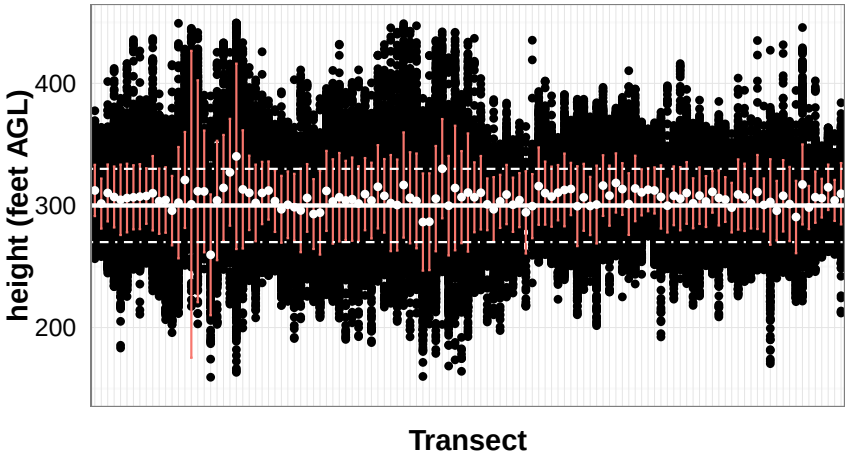

Figure A.6.: Spread of measurements of height (feet, agl) and standard deviation for each of the transects flown.

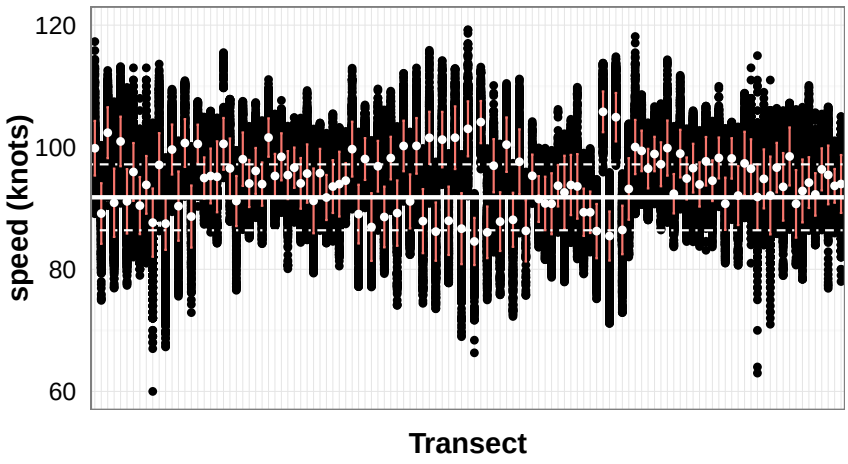

Figure A.7.: Spread of measurements of speed (knots/hrs) and standard deviation for each of the transects flown.

A.2.6. Stratum Summary Statistics

Table A.4.: Summary statistics for stratum and transect level in the PNL.

Strata ID	**Area** (km^2)	**Trns. Spacing**	**Sampled area** (km^2)	**Trns. no.**	**Trns. lenght (km)**	**Search Rate** (km^2/min)	**Av.Veloc. (knots)**	**Veloc. SD**	**Height (ft AGL)**	**Height SD**	**Percentage Sampled**
lim14-east	5534.00	4000.00	589.83	34	1371.13	1.25	94.71	4.02	307.72	24.22	10.66
lim14-west	3248.00	2000.00	681.63	50	1594.85	1.23	94.50	4.41	304.95	34.94	20.99
lim14-north	3189.00	4000.00	338.67	18	790.80	1.25	94.53	4.62	306.91	38.13	10.62
Total/Mean	**11971.00**	**3333.33**	**1610.13**	**102**	**3756.78**	**1.24**	**94.58**	**4.35**	**306.53**	**32.43**	**15.02** [2]

Table A.5.: Summary statistics for stratum and transect level in the southern extension.

Strata ID	**Area** (km^2)	**Trns. Spacing**	**Sampled area** (km^2)	**Trns. no.**	**Trns. lenght (km)**	**Search Rate** (km^2/min)	**Av.Veloc. (knots)**	**Veloc. SD**	**Height (ft AGL)**	**Height SD**	**Percentage Sampled**
lim14-extsouth1	1716.00	10000.00	74.21	7	175.46	1.24	94.84	5.10	302.98	27.41	4.32
lim14-extsouth	1524.00	5000.00	114.78	8	268.50	1.23	93.69	4.26	305.93	22.20	7.53
Total/Mean	**3240.00**	**7500.00**	**188.99**	**15**	**443.96**	**1.23**	**94.26**	**4.68**	**304.46**	**24.80**	**6.27** [3]

[2] weighted mean as contribution of strata to global area
[3] weighted mean as contribution of strata to global area

A.2.7. Timing of Sessions and Duration

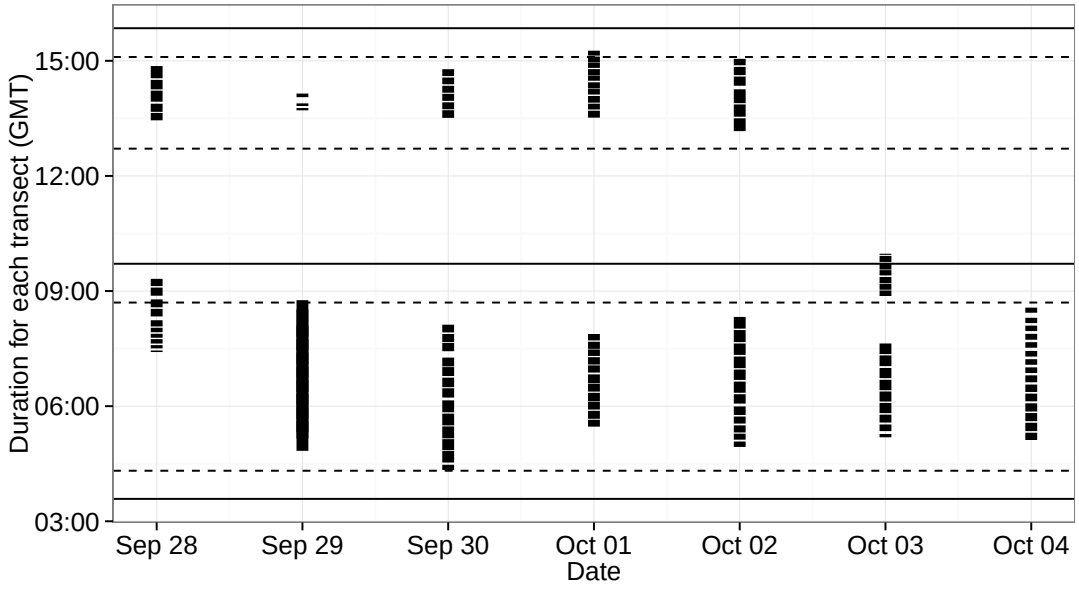

Figure A.8.: Session and transect start and end times (GMT). Solid lines are perceived sunrise and sunset and noon respectively, dashed lines indicate target time of the day for survey sessions.

Table A.6.: Survey session duration, dates and implemented transects for the PNL.

Platform	Session Start	Session Stop	On Transect Time	Off Transect Time	Session Total	Effort Ratio	List of Transects	Strata ID
ZS-IWM	2014-09-28 06:46:56	2014-09-28 09:26:05	85.67	73.48	159.15	0.54	70, 71, 72, 73, 74, 75, 76, 77, 78, 79	lim14_east
ZS-IWM	2014-09-28 13:20:16	2014-09-28 15:19:56	75.55	44.12	119.67	0.63	80, 81, 82, 83, 84	lim14_east
ZS-IWM	2014-09-29 04:29:02	2014-09-29 09:01:47	183.15	89.60	272.75	0.67	85, 86, 87, 88, 89, 90, 91, 92, 93, 94	lim14_east
ZS-IWM	2014-09-29 13:31:00	2014-09-29 15:00:16	13.25	76.02	89.27	0.15	20, 21, 23	lim14_west
ZS-IWM	2014-09-30 04:09:43	2014-09-30 08:26:34	194.33	62.52	256.85	0.76	22, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35	lim14_west
ZS-IWM	2014-09-30 13:15:02	2014-09-30 15:04:34	66.00	43.53	109.53	0.60	36, 37, 38, 39, 40, 41	lim14_west
ZS-IWM	2014-10-01 05:07:56	2014-10-01 08:07:17	128.47	50.88	179.35	0.72	42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52	lim14_west
ZS-IWM	2014-10-01 13:17:56	2014-10-01 15:21:40	90.95	32.78	123.73	0.74	53, 54, 55, 56, 57, 58, 59, 60, 61, 62	lim14_west
ZS-IWM	2014-10-02 04:24:32	2014-10-02 08:37:04	175.00	77.53	252.53	0.69	18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7	lim14_north
ZS-IWM	2014-10-02 12:53:26	2014-10-02 15:13:00	98.17	41.40	139.57	0.70	6, 5, 4, 3, 2, 1	lim14_north
ZS-IWM	2014-10-03 04:47:32	2014-10-03 07:46:00	125.23	53.23	178.47	0.70	103, 102, 101, 100, 99, 98, 97, 96, 95	lim14_east
ZS-IWM	2014-10-03 08:41:37	2014-10-03 10:06:47	57.40	27.77	85.17	0.67	63, 64, 65, 66, 67, 68, 69	lim14_west
ZS-IWM	2014-10-04 05:00:02	2014-10-04 09:08:44	153.22	95.48	248.70	0.62	210, 211, 212, 213, 214, 215, 216, 217, 201, 202, 203, 204, 205, 206, 207	lim14_extsouth, lim14_extsouth1

A.3. Additional Results

A.3.1. Observed Species List

	Common Name	Full name	Species
1	Baboon	Chacma baboon	*Papio ursinus*
2	Bushbuck	Bushbuck	*Tragelaphus scriptus*
3	Bushpig	Bushpig	*Potamochoerus porcus*
4	Buffalo	Cape buffalo	*Syncerus caffer caffer*
5	Duiker	Grey duiker	*Sylvicapra grimmia*
6	Eland	Cape eland	*Taurotragus oryx*
7	Elephant	African elephant	*Loxodonta africana africana*
8	Ground Hornbill	Southern Ground-hornbill	*Bucorvus leadbeateri*
9	Hartebeest	Lichtenstein's hartebeest	*Alcelaphus lichtensteinii*
10	Hippopotamus	Hippopotamus	*Hippopotamus amphibius*
11	Hyaena	Spotted Hyaena	*Crocuta crocuta*
12	Impala	Johnston's impala	*Aepyceros melampus johnstoni*
13	Kudu	Greater kudu	*Tragelaphus strepsiceros*
14	Leopard	Leopard	*Panthera pardus*
15	Lion	Lion	*Panthera leo*
16	Monkey	Vervet monkey	*Cercopithecus aethiops*
17	Reedbuck	Common reedbuck	*Redunca arundinum*
18	Sable	Sable antelope	*Hippotragus niger*
19	Warthog	Warthog	*Phacochoerus aethopicus*
20	Waterbuck	Common waterbuck	*Kobus ellipsiprymnus*
21	Wildebeest	Johnston's wildebeest	*Connochaetes taurinus johnstoni*
22	Zebra	Burchell's zebra	*Equus q. burchellii*
23	Crocodile	Nile crocodile	*Crocodilus niloticus*

A.3.2. Stratum Specific Estimates

A.3.2.1. Limpopo National Park

Limp. east

Table A.7.: Population estimates for lim14-east in the Limpopo National Park.

stratum	species	pop.est.Y	pop.count	pop.var	PRP	lower	upper
lim14-east	Buffalo	525	56	245172	192	56	1533
lim14-east	Bushbuck	9	1	94	210	1	29
lim14-east	Bushpig	94	10	3691	132	10	217
lim14-east	Cattle	22771	2427	18689380	39	13975	31566
lim14-east	Elephant	84	9	4904	169	9	227
lim14-east	Elephant bulls	66	7	4619	211	7	204
lim14-east	Elephant carcass	56	6	839	105	6	115
lim14-east	Elephant carcass 3 and 4	56	6	839	105	6	115
lim14-east	Elephant cows	19	2	374	210	2	58
lim14-east	Ground hornbill	178	19	8362	104	19	364
lim14-east	Impala	422	45	46172	104	45	859
lim14-east	Kudu	666	71	85612	89	71	1261
lim14-east	Nyala	328	35	11628	67	109	548
lim14-east	Old elephant carcass 3	38	4	530	125	4	84
lim14-east	Old elephant carcass 4	19	2	177	144	2	46
lim14-east	Ostrich	75	8	1489	105	8	154
lim14-east	Other carcass	103	11	1076	65	36	170
lim14-east	Shoats	3875	413	1090465	55	1750	5999
lim14-east	Small antelope	38	4	339	100	4	75
lim14-east	Vervet monkey	9	1	95	212	1	29
lim14-east	Warthog	19	2	369	208	2	58
lim14-east	Waterbuck	9	1	94	210	1	29
lim14-east	Wildebeest	9	1	94	210	1	29

Limp. west

Table A.8.: Population estimates for lim14-west in the Limpopo National Park.

stratum	species	pop.est.Y	pop.count	pop.var	PRP	lower	upper
lim14-west	Baboon	38	8	218	78	8	68
lim14-west	Buffalo	710	149	104366	91	149	1359
lim14-west	Bushpig	33	7	543	140	7	80
lim14-west	Cattle	7486	1571	2247112	40	4473	10498
lim14-west	Elephant	677	142	55882	70	202	1152
lim14-west	Elephant bulls	48	10	638	107	10	98
lim14-west	Elephant carcass	95	20	517	48	50	141
lim14-west	Elephant carcass 1 and 2	10	2	77	185	2	27
lim14-west	Elephant carcass 3 and 4	86	18	461	50	43	129
lim14-west	Elephant cows	629	132	56211	76	153	1105
lim14-west	Giraffe	52	11	440	80	11	95
lim14-west	Ground hornbill	33	7	468	130	7	77
lim14-west	Hippo	57	12	1041	113	12	122
lim14-west	Impala	572	120	42357	72	158	985
lim14-west	Kudu	500	105	18739	55	225	775
lim14-west	Nyala	510	107	11668	43	293	727
lim14-west	Old elephant carcass 3	43	9	263	76	10	75
lim14-west	Old elephant carcass 4	43	9	182	63	16	70
lim14-west	Ostrich	148	31	6374	109	31	308
lim14-west	Other carcass	52	11	206	55	24	81
lim14-west	Recent elephant carcass	10	2	77	185	2	27
lim14-west	Roan	5	1	19	184	1	14
lim14-west	Sable	14	3	91	134	3	33
lim14-west	Shoats	1525	320	270608	69	479	2570
lim14-west	Small antelope	43	9	427	97	9	84
lim14-west	Warthog	5	1	19	185	1	14
lim14-west	Waterbuck	262	55	22759	116	55	565
lim14-west	Wildebeest	219	46	7224	78	48	390
lim14-west	Zebra	310	65	7439	56	136	483

Limp. north

Table A.9.: Population estimates for lim14-north in the Limpopo National Park.

stratum	species	pop.est.Y	pop.count	pop.var	PRP	lower	upper
lim14-north	Baboon	9	1	94	218	1	30
lim14-north	Buffalo	104	11	3506	121	11	229
lim14-north	Bushpig	28	3	907	225	3	92
lim14-north	Cattle	5443	578	3359290	71	1576	9310
lim14-north	Elephant	320	34	46329	142	34	774
lim14-north	Elephant bulls	122	13	11916	188	13	353
lim14-north	Elephant carcass	75	8	817	80	15	136
lim14-north	Elephant carcass 3 and 4	75	8	817	80	15	136
lim14-north	Elephant cows	198	21	38242	209	21	610
lim14-north	Giraffe	19	2	182	151	2	47
lim14-north	Impala	132	14	18424	217	14	418
lim14-north	Kudu	301	32	23939	108	32	628
lim14-north	Nyala	556	59	37066	73	149	962
lim14-north	Old elephant carcass 3	9	1	94	218	1	30
lim14-north	Old elephant carcass 4	66	7	833	92	7	127
lim14-north	Other carcass	28	3	495	166	3	75
lim14-north	Shoats	2740	291	1063379	79	564	4916
lim14-north	Small antelope	85	9	1816	106	9	175
lim14-north	Vervet monkey	19	2	190	154	2	48
lim14-north	Wildebeest	19	2	385	220	2	60
lim14-north	Zebra	85	9	7805	220	9	271

A.3.2.2. Southern Extension

ExtenSouth1 (bordering park)

Table A.10.: Population estimates for lim14-extsouth1 in the Southern Extension.

stratum	species	pop.est.Y	pop.count	pop.var	PRP	lower	upper
lim14-extsouth1	Baboon	23	1	558	250	1	81
lim14-extsouth1	Buffalo	277	12	80387	250	12	971
lim14-extsouth1	Cattle	4556	197	5597725	127	197	10345
lim14-extsouth1	Elephant carcass	23	1	560	250	1	81
lim14-extsouth1	Elephant carcass 3 and 4	23	1	560	250	1	81
lim14-extsouth1	Kudu	347	15	54518	165	15	918
lim14-extsouth1	Old elephant carcass 3	23	1	560	250	1	81
lim14-extsouth1	Other carcass	23	1	558	250	1	81
lim14-extsouth1	Shoats	462	20	143599	200	20	1390
lim14-extsouth1	Small antelope	69	3	1130	119	3	152

ExtenSouth

Table A.11.: Population estimates for lim14-extsouth in the Southern Extension.

stratum	species	pop.est.Y	pop.count	pop.var	PRP	lower	upper
lim14-extsouth	Baboon	13	1	205	255	1	47
lim14-extsouth	Buffalo	80	6	5140	213	6	249
lim14-extsouth	Bushbuck	13	1	208	257	1	47
lim14-extsouth	Bushpig	27	2	821	255	2	94
lim14-extsouth	Cattle	1168	88	790608	180	88	3271
lim14-extsouth	Elephant	173	13	17437	181	13	485
lim14-extsouth	Elephant cows	173	13	17437	181	13	485
lim14-extsouth	Giraffe	66	5	5163	256	5	236
lim14-extsouth	Impala	332	25	90428	214	25	1043
lim14-extsouth	Kudu	345	26	46057	147	26	853
lim14-extsouth	Nyala	80	6	2635	152	6	201
lim14-extsouth	Ostrich	13	1	201	253	1	47
lim14-extsouth	Other carcass	40	3	866	175	3	109
lim14-extsouth	Small antelope	212	16	8272	101	16	428
lim14-extsouth	Warthog	66	5	2631	183	5	188

A.4. Survey Design and Implementation GIS Files

A list of accompanying files provided with this report are described and listed below. All files are provided in a Geographic Coordinate System (decimal degrees) / WGS-84 geodetic system. The UTM zone of the study area is UTM-37S. The time format is provided in ISO 8601 (2014-10-07T08:23:19.120Z). All data is provided in a convenient single file using SQ-Light[4]/SpatialLight[5] (both in public domain. available for free).

DESIGN

1. **moz_lim_trns_dd <polyline>**

Column Name	Length	Class	Mode
TRNSID	530	-none-	numeric
GLOBALID	530	factor	numeric
STRATAID	530	factor	numeric
X_BEG	530	-none-	numeric
Y_BEG	530	-none-	numeric
X_END	530	-none-	numeric
Y_END	530	-none-	numeric
des_lengthkm	530	-none-	numeric

2. **moz_lim_strata_dd <polygon>**

Column Name	Length	Class	Mode
STRATAID	26	factor	numeric
STRATA_NAME	26	factor	numeric
GLOBALID	26	factor	numeric
AREA_kms	26	-none-	numeric
SPACING_m	26	-none-	numeric
BLINE_km	26	-none-	numeric

3. **moz_lim_global_dd <polygon>**

Column Name	Length	Class	Mode
ROWID	2	-none-	numeric
GLOBALID	2	-none-	character
GNAME	2	-none-	character
GAREA_KMSQ	2	-none-	numeric

[4] http://www.sqlite.org/
[5] http://www.gaia-gis.it/gaia-sins/

IMPLEMENTATION

1. **moz_lim_obs_2014_01_dd <point>**

   - global ID <globalid>

   - starta ID <strataid>

   - transect ID <trnsid>

   - observation ID <obsid>

   - x coordinates <xcoords>

   - y coordinates <ycoords>

2. **moz_lim_meta_2014_01_dd <polyline, 1 sec segments>**

   - unique row ID <rowid>

   - Aircraft <platformID>

   - date <date>

   - datetime <ISOtime>

   - Trasnect ID <trnsid>

   - x coordinates <xcoords>

   - y coordinates <ycoords>

   - segment length <slength_m>

   - speed <speed_knts>

   - height <height_ft>

   - course made good <cmg_d>

A.5. Sample Locations

Table A.12.: Transect start and end point coordinates in decimal degrees.

TRANSECT ID	STRATA ID	LON beg.	LAT beg.	LON end.	LAT end.	LENGHT (km)
1	lim14_north	31.52130	-23.04190	31.82090	-23.04440	30.7
2	lim14_north	31.50870	-23.00560	31.86100	-23.00860	36.1
3	lim14_north	31.49610	-22.96940	31.93740	-22.97300	45.2
4	lim14_north	31.48350	-22.93310	32.07510	-22.93770	60.7
5	lim14_north	31.47090	-22.89690	32.05500	-22.90140	59.9
6	lim14_north	31.45840	-22.86070	32.01720	-22.86510	57.3
7	lim14_north	31.44580	-22.82440	31.98610	-22.82880	55.5
8	lim14_north	31.43330	-22.78820	31.96600	-22.79250	54.7
9	lim14_north	31.42070	-22.75190	31.94600	-22.75620	53.9

Continued on next page

Table A.12 – continued from previous page

TRANSECT ID	STRATA ID	LON beg.	LAT beg.	LON end.	LAT end.	LENGHT(km)
10	lim14_north	31.40820	-22.71570	31.91050	-22.71990	51.6
11	lim14_north	31.39560	-22.67940	31.86860	-22.68350	48.6
12	lim14_north	31.38310	-22.64320	31.84100	-22.64710	47.1
13	lim14_north	31.37060	-22.60690	31.80670	-22.61070	44.8
14	lim14_north	31.35810	-22.57070	31.72160	-22.57400	37.4
15	lim14_north	31.34560	-22.53440	31.67500	-22.53750	33.9
16	lim14_north	31.33310	-22.49810	31.63050	-22.50100	30.6
17	lim14_north	31.32060	-22.46190	31.60550	-22.46460	29.3
18	lim14_north	31.30790	-22.42560	31.56290	-22.42810	26.2
19	lim14_north	31.28120	-22.38920	31.30240	-22.38950	2.2
20	lim14_west	31.86570	-23.94180	31.96790	-23.94250	10.4
21	lim14_west	31.82690	-23.92340	31.97880	-23.92450	15.5
22	lim14_west	31.80500	-23.90520	31.98970	-23.90650	18.8
23	lim14_west	31.78310	-23.88700	32.00050	-23.88850	22.1
24	lim14_west	31.76920	-23.86880	32.26740	-23.87200	50.7
25	lim14_west	31.75980	-23.85070	32.27490	-23.85390	52.5
26	lim14_west	31.75050	-23.83250	32.28120	-23.83590	54.1
27	lim14_west	31.74110	-23.81440	32.27710	-23.81780	54.6
28	lim14_west	31.73170	-23.79620	32.26040	-23.79970	53.9
29	lim14_west	31.72240	-23.77810	32.16820	-23.78110	45.4
30	lim14_west	31.71300	-23.76000	32.14190	-23.76290	43.7
31	lim14_west	31.70360	-23.74180	32.11740	-23.74470	42.2
32	lim14_west	31.69640	-23.72370	32.09290	-23.72650	40.4
33	lim14_west	31.69600	-23.70560	32.07300	-23.70830	38.4
34	lim14_west	31.69560	-23.68760	32.05680	-23.69020	36.8
35	lim14_west	31.69510	-23.66950	32.04060	-23.67200	35.2
36	lim14_west	31.69470	-23.65140	32.02430	-23.65390	33.6
37	lim14_west	31.69430	-23.63340	32.00840	-23.63570	32.0
38	lim14_west	31.68820	-23.61530	31.99300	-23.61750	31.1
39	lim14_west	31.67130	-23.59700	31.97760	-23.59940	31.3
40	lim14_west	31.65430	-23.57880	31.95560	-23.58120	30.8
41	lim14_west	31.63740	-23.56060	31.94850	-23.56300	31.8
42	lim14_west	31.62040	-23.54240	31.94380	-23.54490	33.0
43	lim14_west	31.60350	-23.52420	31.93930	-23.52690	34.3
44	lim14_west	31.58660	-23.50600	31.93470	-23.50880	35.5
45	lim14_west	31.56970	-23.48780	31.92910	-23.49070	36.7
46	lim14_west	31.55880	-23.46960	31.92360	-23.47260	37.3
47	lim14_west	31.55710	-23.45150	31.91390	-23.45440	36.4
48	lim14_west	31.55540	-23.43350	31.88640	-23.43620	33.8
49	lim14_west	31.55380	-23.41540	31.86300	-23.41790	31.6

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Table A.12 – continued from previous page

TRANSECT ID	STRATA ID	LON beg.	LAT beg.	LON end.	LAT end.	LENGHT(km)
50	lim14_west	31.55210	-23.39730	31.85940	-23.39980	31.4
51	lim14_west	31.55040	-23.37920	31.85580	-23.38180	31.2
52	lim14_west	31.54870	-23.36110	31.85210	-23.36370	31.0
53	lim14_west	31.54710	-23.34310	31.83350	-23.34550	29.3
54	lim14_west	31.54810	-23.32500	31.82620	-23.32730	28.4
55	lim14_west	31.54980	-23.30700	31.81890	-23.30920	27.5
56	lim14_west	31.55150	-23.28890	31.81330	-23.29110	26.8
57	lim14_west	31.55320	-23.27090	31.80890	-23.27300	26.2
58	lim14_west	31.55490	-23.25280	31.80450	-23.25490	25.5
59	lim14_west	31.55660	-23.23480	31.80000	-23.23680	24.9
60	lim14_west	31.55430	-23.21670	31.79750	-23.21870	24.9
61	lim14_west	31.55110	-23.19860	31.79750	-23.20070	25.2
62	lim14_west	31.54800	-23.18050	31.79820	-23.18260	25.6
63	lim14_west	31.54490	-23.16240	31.79970	-23.16460	26.1
64	lim14_west	31.54180	-23.14430	31.80120	-23.14650	26.6
65	lim14_west	31.53860	-23.12620	31.80260	-23.12850	27.0
66	lim14_west	31.53550	-23.10820	31.80410	-23.11040	27.5
67	lim14_west	31.53240	-23.09010	31.80560	-23.09240	28.0
68	lim14_west	31.52930	-23.07200	31.80700	-23.07430	28.5
69	lim14_west	31.52610	-23.05390	31.57210	-23.05430	4.7
70	lim14_east	32.50320	-24.16220	32.57830	-24.16250	7.6
71	lim14_east	32.49120	-24.12610	32.63230	-24.12650	14.3
72	lim14_east	32.47190	-24.08990	32.66070	-24.09040	19.2
73	lim14_east	32.46470	-24.05370	32.63620	-24.05420	17.4
74	lim14_east	32.43590	-24.01750	32.63370	-24.01810	20.1
75	lim14_east	32.33200	-23.98090	32.60500	-23.98190	27.8
76	lim14_east	32.26380	-23.94450	32.60010	-23.94580	34.2
77	lim14_east	32.26150	-23.90840	32.61120	-23.90960	35.6
78	lim14_east	32.26770	-23.87230	32.61110	-23.87350	35.0
79	lim14_east	32.28320	-23.83620	32.59690	-23.83740	32.0
80	lim14_east	32.26130	-23.80000	32.56590	-23.80110	31.0
81	lim14_east	32.13920	-23.76320	32.55060	-23.76500	41.9
82	lim14_east	32.08790	-23.72680	32.53860	-23.72880	45.9
83	lim14_east	32.05530	-23.69050	32.52750	-23.69260	48.1
84	lim14_east	32.02430	-23.65420	32.52140	-23.65650	50.7
85	lim14_east	31.99340	-23.61780	32.51540	-23.62030	53.3
86	lim14_east	31.95460	-23.58150	32.50580	-23.58420	56.2
87	lim14_east	31.94420	-23.54530	32.49470	-23.54800	56.2
88	lim14_east	31.93390	-23.50910	32.48660	-23.51190	56.4
89	lim14_east	31.92350	-23.47290	32.47850	-23.47570	56.7

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Table A.12 – continued from previous page

TRANSECT ID	STRATA ID	LON beg.	LAT beg.	LON end.	LAT end.	LENGHT(km)
90	lim14_east	31.88630	-23.43650	32.45050	-23.43950	57.6
91	lim14_east	31.85950	-23.40010	32.40650	-23.40320	55.9
92	lim14_east	31.85290	-23.36400	32.37770	-23.36690	53.6
93	lim14_east	31.82790	-23.32770	32.35000	-23.33070	53.4
94	lim14_east	31.81460	-23.29140	32.31670	-23.29440	51.4
95	lim14_east	31.80360	-23.25520	32.28680	-23.25820	49.4
96	lim14_east	31.79760	-23.21910	32.27230	-23.22200	48.6
97	lim14_east	31.79660	-23.18290	32.26560	-23.18580	48.0
98	lim14_east	31.79980	-23.14680	32.26850	-23.14970	48.0
99	lim14_east	31.80300	-23.11070	32.26770	-23.11360	47.6
100	lim14_east	31.80620	-23.07460	32.24170	-23.07730	44.6
101	lim14_east	31.82810	-23.03860	32.19390	-23.04090	37.5
102	lim14_east	31.86690	-23.00280	32.15050	-23.00460	29.1
103	lim14_east	31.95510	-22.96730	32.11170	-22.96820	16.1
201	lim14_extsouth1	32.25390	-24.36360	31.99880	-24.36210	25.9
202	lim14_extsouth1	32.25410	-24.45390	32.01000	-24.45250	24.8
203	lim14_extsouth1	32.25440	-24.54420	32.00510	-24.54280	25.2
204	lim14_extsouth1	32.25520	-24.63450	32.00030	-24.63310	25.8
205	lim14_extsouth1	32.25710	-24.72490	32.00580	-24.72340	25.4
206	lim14_extsouth1	32.25600	-24.81520	32.01220	-24.81370	24.6
207	lim14_extsouth1	32.25540	-24.90550	32.01760	-24.90410	24.0
209	lim14_extsouth1	32.14030	-23.93080	31.97560	-23.92980	16.8
210	lim14_extsouth	32.20320	-23.97630	31.89420	-23.97430	31.4
211	lim14_extsouth	32.26320	-24.02170	31.89730	-24.01950	37.2
212	lim14_extsouth	32.26160	-24.06690	31.90040	-24.06470	36.7
213	lim14_extsouth	32.25990	-24.11200	31.90340	-24.10990	36.2
214	lim14_extsouth	32.25820	-24.15720	31.90650	-24.15510	35.7
215	lim14_extsouth	32.25650	-24.20230	31.91920	-24.20030	34.3
216	lim14_extsouth	32.25480	-24.24750	31.94890	-24.24570	31.1
217	lim14_extsouth	32.25050	-24.29100	31.97870	-24.29100	27.6

A.6. Supporting letter

REPÚBLICA DE MOÇAMBIQUE

MINISTERIO DE AGRICULTURA

DIRECÇÃO NACIONAL DE TERRAS E FLORESTAS

Proposta: nr. 194/MINAG/DNTF/2014

PARECER	DESPACHO
Sua Excelência, 1. Concordo com a proposta e julgo de autorizar a realização do Censo Nacional do Elefante e que a DNTF coordene a equipe multisetorial 2. Conforme a informação apresentada, o Censo não acarreta custos para o MINAG. A Coordenação Superior 01/9/14	Autorizo 02.09.14

À

Sua Excelência

Ministro da Agricultura

MAPUTO

Maputo, 28 Agosto de 2014

Assunto: **Realização do censo nacional do Elefante**

1. Recebemos da WCS (Sociedade para a Conservação da Fauna), a 25 de Julho de 2014, uma proposta de projecto para a realização do censo nacional do Elefante, a ter lugar entre Setembro e Novembro do ano corrente. O projecto de realização do censo nacional do Elefante em Moçambique, surge na sequência das recomendações da Cimeira Pan-Africana do Elefante, que teve lugar em Gaborone, de 2 a 4 de Dezembro de 2013, que visava discutir e recomendar medidas urgentes para a conservação do Elefante Africano para responder a situação actual da caça furtiva e tráfico de produtos de fauna bravia na região que ameaça seriamente o desaparecimento da espécie em muitas partes do continente;

MINISTÉRIO DA AGRICULTURA

2. Em resposta às recomendações da Cimeira de Gaborone, teve lugar entre 28 e 29 de Janeiro de 2014, em Kasane-Botswana, uma reunião de especialistas na matéria, onde foram delineadas acções conducentes à realização de um censo geral do Elefante em África, que foi designado por "Censo Aéreo dos Elefantes em África". Para o efeito foi constituída, uma equipe de trabalho, designada por ***PAASE*** (Pan- African Aerial Survey of Elephants) encarregada de definir os "padrões e manuais para o censo, assim como identificar as organizações não governamentais que vão apoiar técnica e metodologicamente a iniciativa nos vários países. Foi assim, que foi indigitada a Wildlife Conservation Society (WCS) para facilitar a realização do Censo Nacional do Elefante em Mozambique, Chade, Sudão do Sul, Camarões, República Democrática do Congo, Mali e República Centro Africana;

3. Pretende-se com a contagem aérea Pan-Africana do Elefante, que seja a maior desde os anos 70, com particularidade desta ser transfronteiriça e simultânea em todos os países de ocorrência do elefante para evitar a duplicação;

4. O último censo nacional de fauna bravia, realizado pelo Ministério da Agricultura em 2008, estimou uma população de 22,000 elefantes. Entretanto, de lá para cá, têm sido reportados altos índices de mortes de elefantes, sobretudo por caçadores furtivos facto que preocupa todos os países da região. A informação disponível sobre a mortalidade de elefantes, sobretudo na região norte do país, sugere que a caça furtiva sozinha é responsável por morte de pelo menos mil elefantes por ano. Este valor ultrapassa a taxa máxima de crescimento do elefante em África. Se esta tendência continuar, nos próximos cinco anos poderemos começar a assistir a um declínio do número de elefantes em Moçambique;

5. O censo de fauna bravia é uma actividade prevista na Estratégia de Gestão de Conflito Homem-Fauna Bravia, Resolução 58/2009, 11 de Agosto, principalmente nas áreas de alto potencial de fauna e onde o conflito Homem-fauna bravia é crítico, afectando na segurança alimentar por destruição de culturas e perda de vidas humanas.

6. Trata-se de um projecto de dois anos, iniciado em Fevereiro de 2014 para produzir informação sobre a distribuição correcta dos efectivos de elefantes e sua distribuição para criar informação de base que irá servir aos esforços de conservação no país. Um conhecimento do número e da distribuição dos elefantes permite melhor alocação e gestão das quotas atribuídas ao país para os operadores privados, das quais o estado arrecada contribuições financeiras para o desempenho da sua economia e tomada de medidas adequadas para a gestão do conflito Homem-fauna bravia.

7. Tendo em conta a necessidade do envolvimento das instituições que respondem pela gestão da fauna bravia no país, há necessidade de criação de uma equipa técnica multi-sectorial composta por representantes dos Ministérios da Agricultura, Turismo e Coordenação da Acção Ambiental, a ser coordenada pela Direcção Nacional de Terras e Florestas, representada pelo chefe do Departamento de Fauna Bravia, Senhor Marcelino Foloma e pela técnica Rezia Cumbi.

8. Neste contexto e havendo necessidade da realização do censo do elefante no país para responder ao imperativo de actualização e sistematização dos dados sobre esta espécie em Moçambique, vimos através desta solicitar, à Vossa Excelência autorizar a DNTF a coordenar o censo e a participação dos técnicos supracitados para integrar a equipa técnica.

À Consideração de Vossa Excelência

O Director Nacional

Simão Pedro Santos Joaquim
(Técnico Superior N1)

Anexos:

i) Cópia do Ofício da WCS (Wildlife Conservation Society)
ii) Nota conceptual do projecto
iii) Cópia do relatório da Cimeira de Gaberone