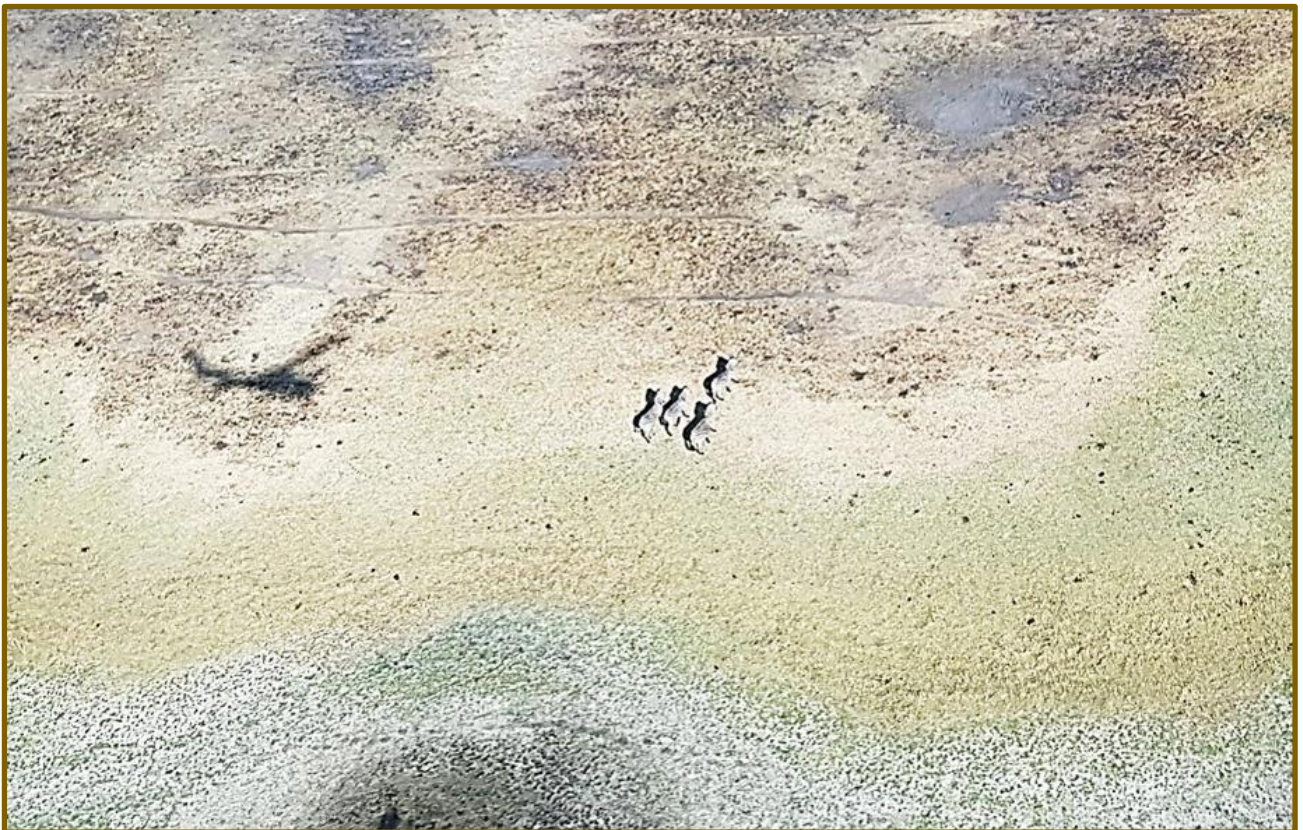




AERIAL SURVEY OF WILDLIFE

IN EASTERN ZAMBEZI REGION

OCTOBER 2019



D. St.C. Gibson & G.C. Craig



DG Ecological Consulting

The 2015 aerial survey and census of wildlife in eastern Zambezi Region, Namibia was commissioned by the Rooikat Trust, Namibia

Funding: Funding for the aerial survey was provided by the Rooikat Trust with partial support from KfW

Copyright: 2019 Rooikat Trust

Reproduction of this publication for resale or other commercial purposes is prohibited without prior written permission of the copyright holder.

Citation: Gibson D. St.C. & G.C. Craig 2019 *Aerial Survey of Wildlife in Eastern Zambezi Region October 2019*. Rooikat Trust, Windhoek, Namibia

Disclaimer: Opinions expressed in this publication do not necessarily reflect those of the Rooikat Trust. All technical queries should be addressed to the authors.

AERIAL SURVEY OF WILDLIFE IN EASTERN ZAMBEZI REGION OCTOBER 2019

SUMMARY

An aerial survey of wildlife and domestic livestock took place in eastern Zambezi Region from 5th to 6th October 2019. A total area of 2751km² was sampled at intensities between 30% and 40%.

The estimates of numbers of each species are tabulated below.

SPECIES	Pop. est.	95%Range	
Zebra	5713	3598	- 7828
All Elephants	653	257	- 1165
ElephantFamily	622	244	- 1132
ElephantBull	30	13	- 53
Buffalo	394	170	- 920
Giraffe	26	8	- 53
Hippopotamus	234	83	- 391
Impala	413	143	- 736
Kudu	36	11	- 68
Lechwe	46	20	- 114
Monkey			
Reedbuck	13	4	- 28
Sable	26	8	- 71
Warthog	100	32	- 194
Waterbuck	7	3	- 21
Wildebeest	1068	348	- 2067
Crocodile	51	21	- 83
GroundHornbill	2	1	- 7
Ostrich	3	1	- 9
Pelican	353	150	- 1013
Saddlebill			
OtherCarcass 1	10	4	- 22
OtherCarcass 2	8	3	- 17
OtherCarcass 3	5	2	- 11
OtherCarcass 4	17	7	- 30
Pig	133	45	- 277
Horse	3	1	- 9
Cattle	60630	52913	- 68346
Sheep/goats	1216	705	- 1727

TABLE OF CONTENTS

1. INTRODUCTION	1
2. RESULTS AND COMMENTS	2
2.1. Reporting format	2
2.2. Observations of Wildlife	3
2.2.1. Zebra.....	3
2.2.2. Buffalo	5
2.2.3. Elephants.....	6
2.2.4. Giraffe.....	7
2.2.5. Hippopotamus.....	8
2.2.6. Impala.....	9
2.2.7. Kudu	10
2.2.8. Lechwe.....	11
2.2.9. Reedbuck.....	12
2.2.10. Sable	13
2.2.11. Warthog.....	14
2.2.12. Waterbuck	15
2.2.13. Wildebeest.....	16
2.2.14. Crocodile.....	17
2.2.15. Ground Hornbill	18
2.2.16. Ostrich.....	19
2.2.17. Livestock	20
2.2.18. Carcasses other than elephants	21
2.2.19. Other Observations – human activity and settlement.....	22
2.2.20. Other Observations – fishing activities.....	23
3. REFERENCES.....	24
APPENDIX I: METHODS	25
a. Survey design	25
b. Sampling intensity	25
c. Selection of transects.....	26
d. Data collection.....	27
e. Searching rate	27
f. Mapping wildlife distribution.....	27
g. Data analysis.....	28
h. Species and attributes recorded.	28
APPENDIX II: RESULTS	29
a. Stratum statistics.....	30
b. Calibration of strip widths	30
c. Maintenance of height.....	31
d. Flight speeds.....	31
APPENDIX III: RESULTS BY STRATUM	32
Estimates of numbers, densities and confidence limits.....	32

TABLE OF FIGURES

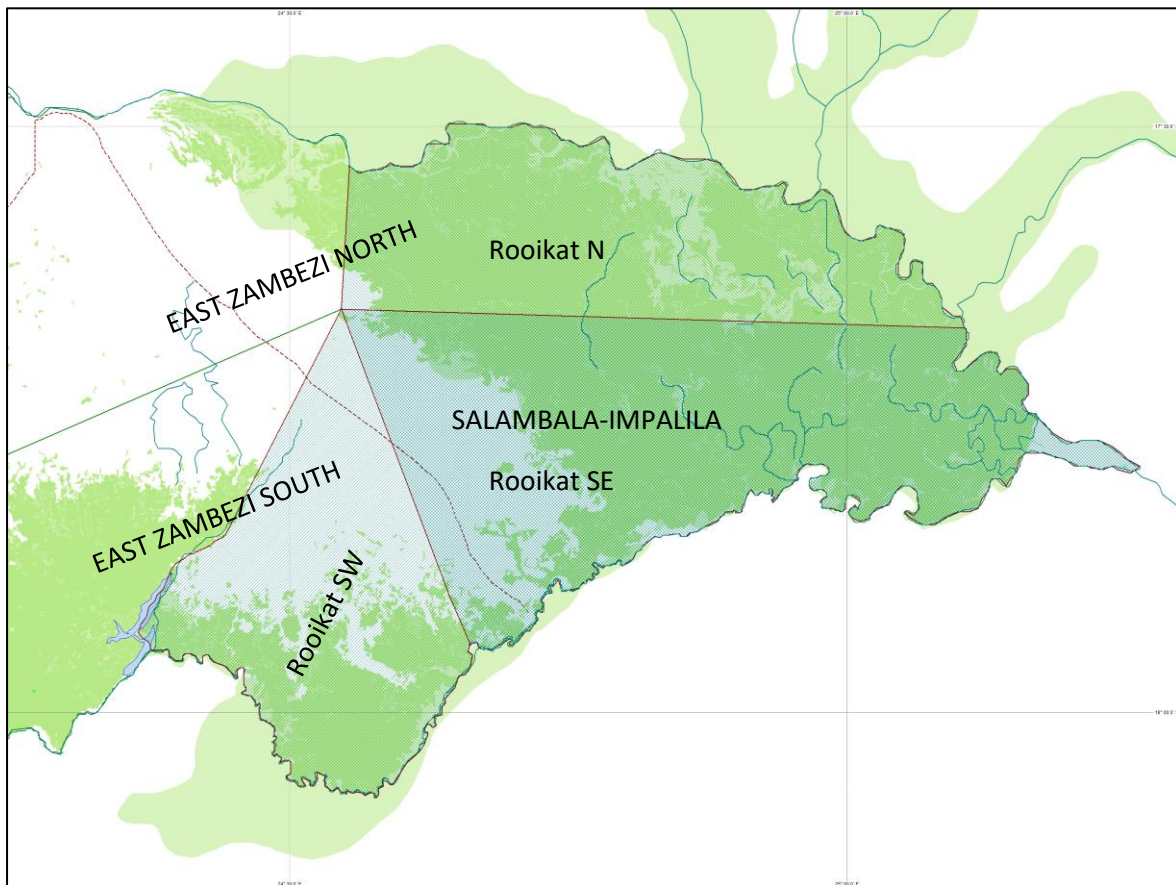
Figure 1 Rooikat survey strata 2019 (shaded).....	1
Figure 2 Sightings of zebra in eastern Zambezi Region 2019.....	3
Figure 3 Sightings of zebras in relation to villages	4
Figure 4 Sightings of zebra in Zambezi Region 2019.....	4
Figure 5 Sightings of buffalo.....	5
Figure 6 Sightings of elephants	6
Figure 7 Sightings of giraffe.....	7
Figure 8 Sightings of hippo	8
Figure 9 Sightings of impala	9
Figure 10 Sightings of kudu	10
Figure 11 Sightings of lechwe.....	11
Figure 12 Sightings of reedbuck	12
Figure 13 Sightings of sable.....	13
Figure 14 Sightings of warthog.....	14
Figure 15 Sightings of waterbuck	15
Figure 16 Sightings of wildebeest	16
Figure 17 Sightings of crocodile	17
Figure 18 Sightings of ground hornbill	18
Figure 19 Sightings of ostrich	19
Figure 20 Sightings of domestic livestock	20
Figure 21 Sightings of carcasses other than elephants.....	21
Figure 22 Sightings of villages, cultivation and cattle posts 2019	22
Figure 23 Sightings of fishing activities 2019	23
Figure 24 Transects selected 2019	26
Figure 25 Tracks of flights 2019	29

AERIAL SURVEY OF WILDLIFE IN EASTERN ZAMBEZI REGION OCTOBER 2019

1. INTRODUCTION

This survey was an addition to, and overlaps with a census of wildlife and other attributes in the whole Zambezi Region. The objective was to obtain estimates of numbers of wildlife, in particular zebra, with a precision that would be as high as possible within resource constraints.

To achieve this, three new strata (Rooikat N, SE and SW) were sampled twice and the data combined with information from the results of the regional survey strata (East Zambezi N and S). These are displayed in Fig. 1.



(East Zambezi north and south and Salambala-Impalila refer to the strata for the full Zambezi survey)

2. RESULTS AND COMMENTS

2.1. Reporting format

This report uses a simple format, with the main section describing estimated numbers and distributions of animals and attributes. For each species, a table provides the estimated number per stratum with its 95% confidence range. This “range” refers to the range within which there is a 95% probability that the true number falls (i.e. it is the 95% confidence interval). Strictly, for most species this is actually the range within which 95% of independent *estimates* made by the same method would fall. The true value is likely to be higher on average because of undercounting bias.

The numbers actually seen by the observers are also provided. “No. in” is the number of animals seen within sampling strips and “No. out” is the number seen outside of the sampling strips. Where animals were seen only outside of the sampling strips no estimate can be given but the information can be used to show that the species occurs and where it occurred.

Wildlife species in this section are arranged in alphabetical order of their common names with the exception of zebra which is placed first. At the end of the wildlife section, the carcasses of species other than elephant are reported. These are followed by sightings of other attributes.

The estimates results section is followed by details of the survey and analysis methods. Data for the results of calibration and details of heights and speeds can be found in the report for the full Zambezi Region survey.

Results of estimated number by stratum are given in Appendix II.

2.2. Observations of Wildlife

This design of this survey was intended to provide improved precision particularly of estimates of zebra. The estimates of most other species are imprecise largely because the numbers were low or, for example in the case of buffalo, because their distribution is clumped.

2.2.1. Zebra

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./100km ²
Rooikat SW	1718	536	601	61.9	655 - 2782	239.31
Rooikat SE	2582	1079	1563	48.6	1326 - 3838	207.42
Rooikat N	1412	433	250	97.9	433 - 2795	179.24
Survey Overall	5713	2048	2414	37.0	3598 - 7828	207.67

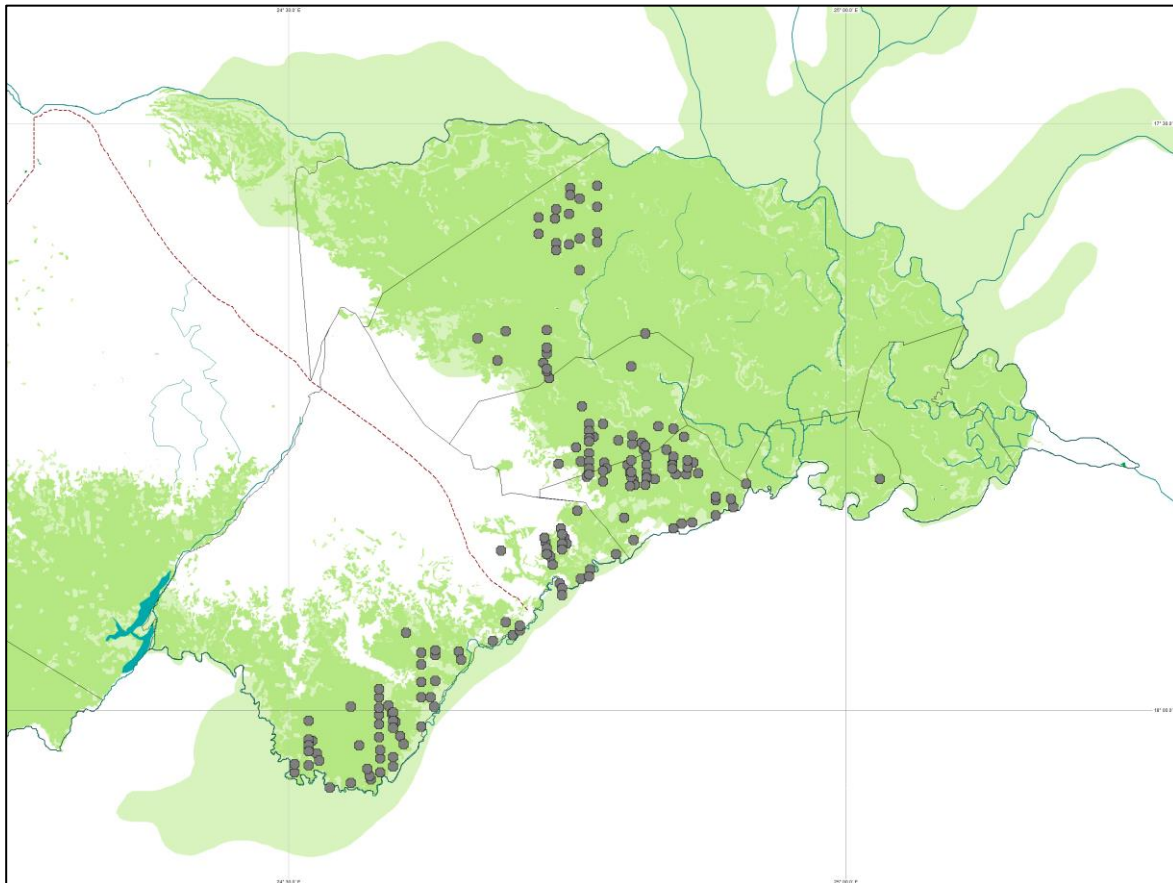


Figure 2 Sightings of zebra in eastern Zambezi Region 2019

The total number estimated for the whole Zambezi Region was $10767 \pm 39.6\%$. Thus the population on the eastern floodplains during the 2019 represents 53.1%. A previous survey in June 2013, done when the plains were flooded estimated the population for the whole Region as only $1421 \pm 44.5\%$. At that time there were no zebra were seen east of Sobbe Conservancy near Mudumu National Park.

In 2019, zebra were seen in suitable grasslands near water. They largely appear to avoid dense areas of villages (Fig 3) although they share the floodplains with cattle.

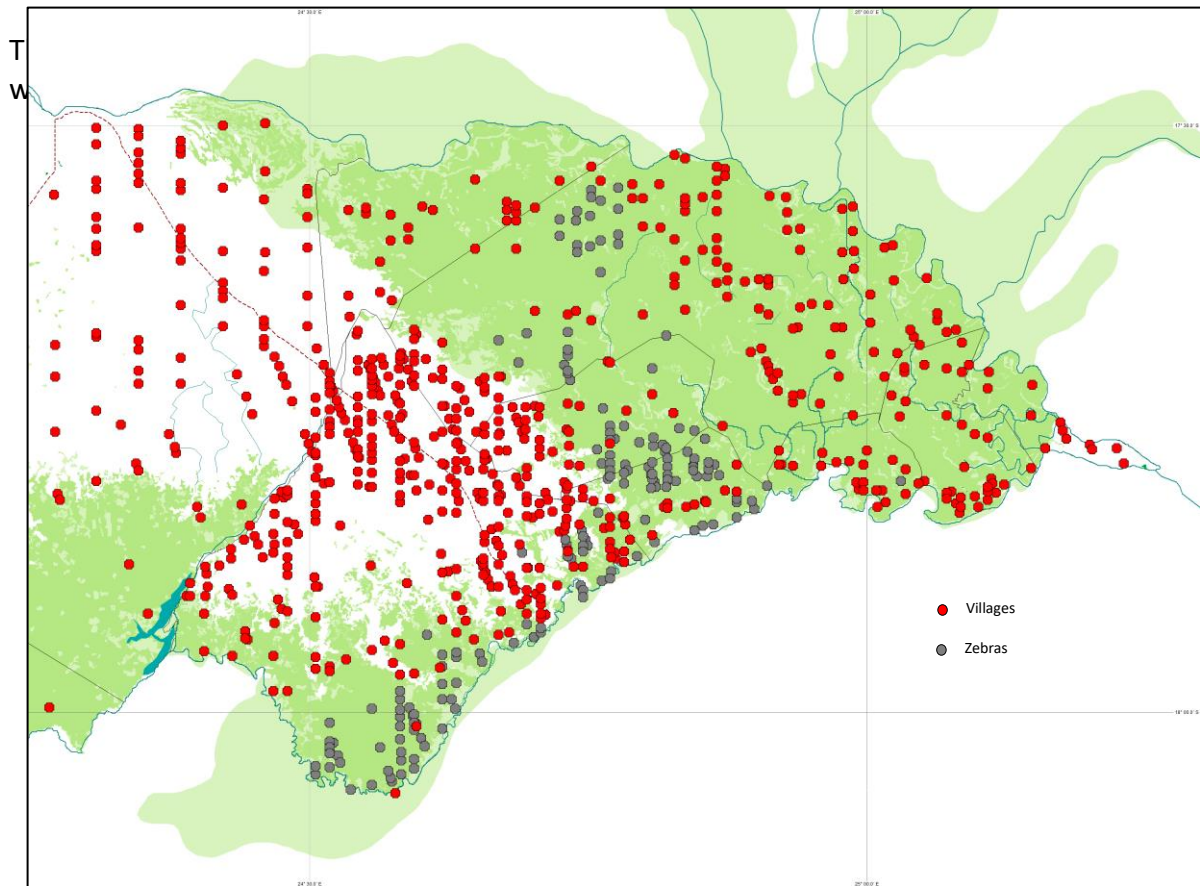


Figure 3 Sightings of zebras in relation to villages

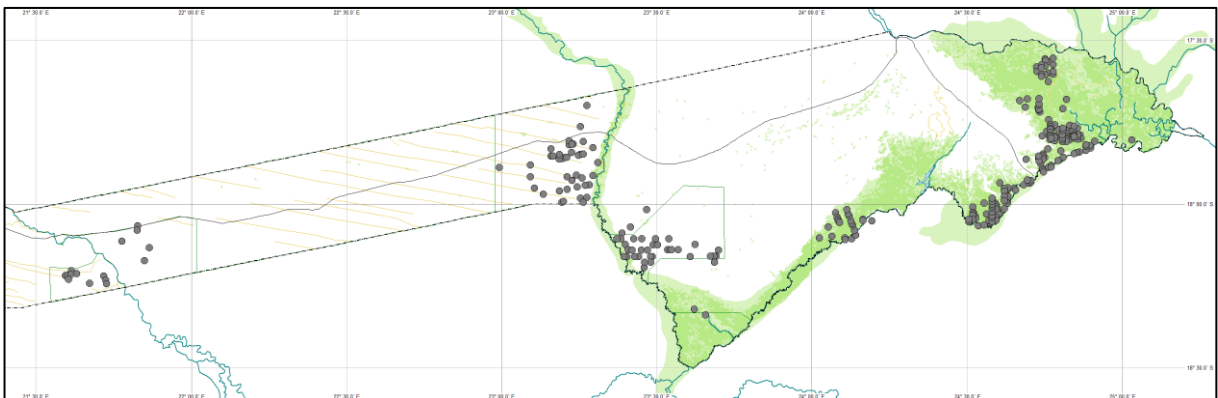


Figure 4 Sightings of zebra in Zambezi Region 2019

2.2.2. Buffalo

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./100km ²
Rooikat SW	0					
Rooikat SE	394	170	1118	135.2	170 - 926	31.62
Rooikat N	0					
Survey Overall	394	170	1118	133.8	170 - 920	14.31

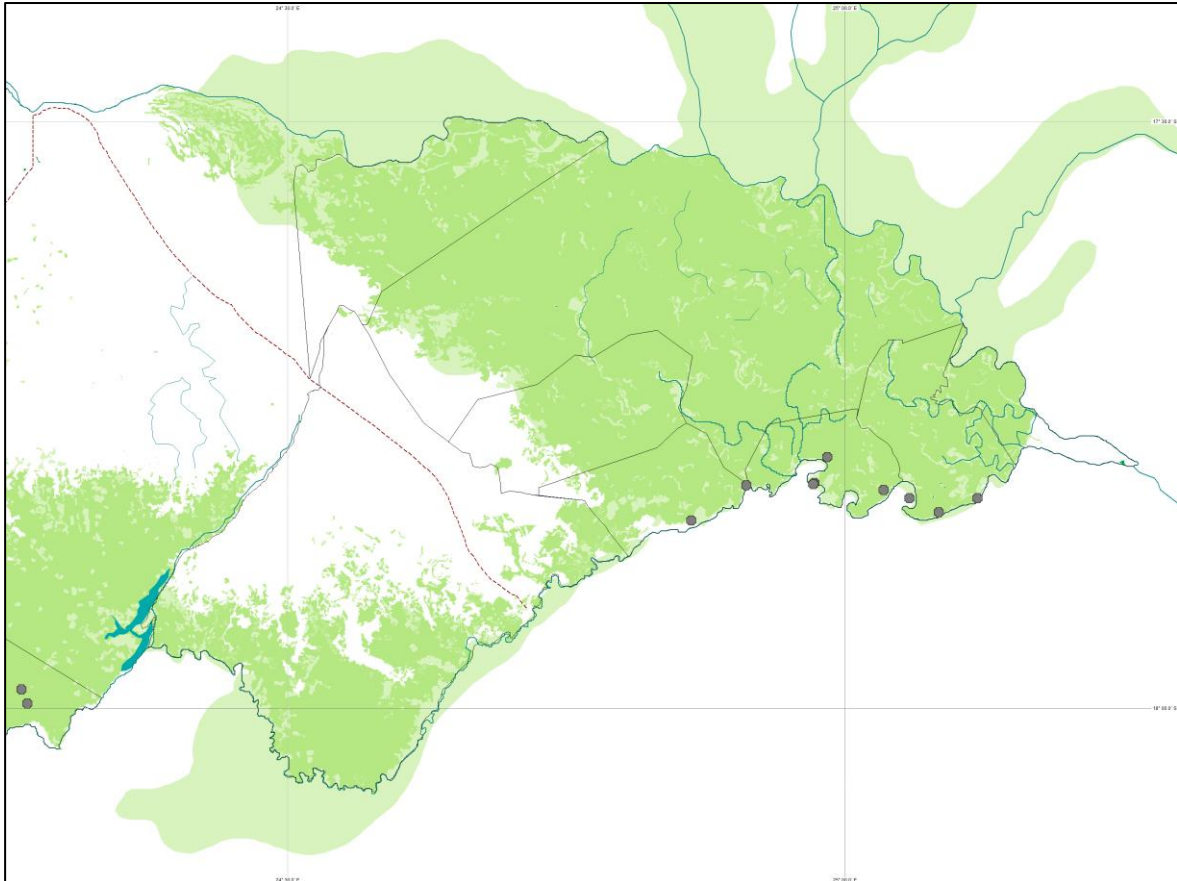


Figure 5 Sightings of buffalo

Buffalo were only seen along the Chobe River, immediately opposite the Chobe National Park in Botswana.

2.2.3. Elephants

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./100km ²
Rooikat SW	146	46	4	189.0	46 - 421	20.29
Rooikat SE	507	211	187	86.6	211 - 946	40.71
Rooikat N	0					
Overall	653	257	191	78.6	257 - 1165	23.72
Elephants in family groups						
Rooikat SW	146	46	4	189.0	46 - 421	20.29
Rooikat SE	477	198	181	91.4	198 - 912	38.29
Rooikat N	0					
Overall	622	244	185	81.9	244 - 1132	22.62
Elephants in bull groups						
Rooikat SW	0					
Rooikat SE	30	13	6	76.4	13 - 53	2.43
Rooikat N	0					
Overall	30	13	6	75.6	13 - 53	1.1

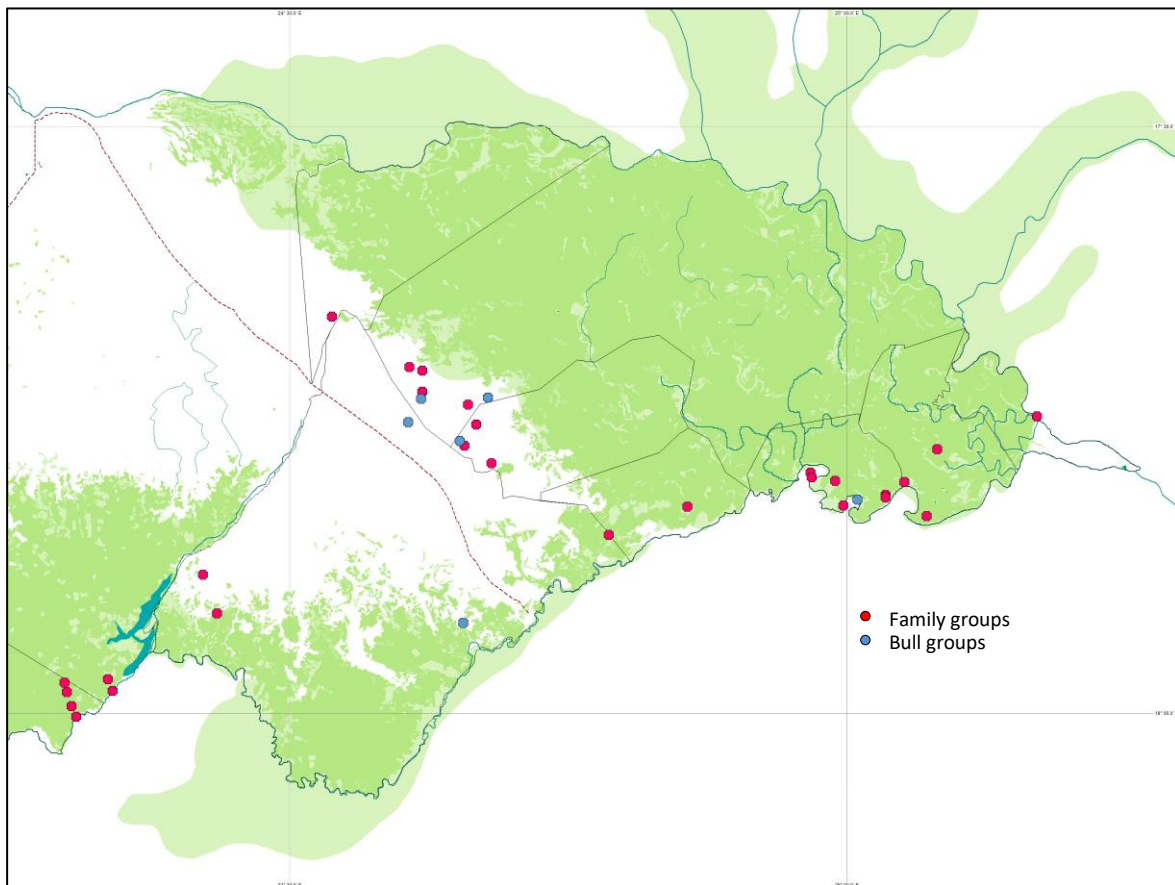


Figure 6 Sightings of elephants

2.2.4. Giraffe

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	26	8	1	107.5	8 - 53	3.57
Rooikat SE	0					
Rooikat N	0					
Survey Overall	26	8	1	106.2	8 - 53	0.93

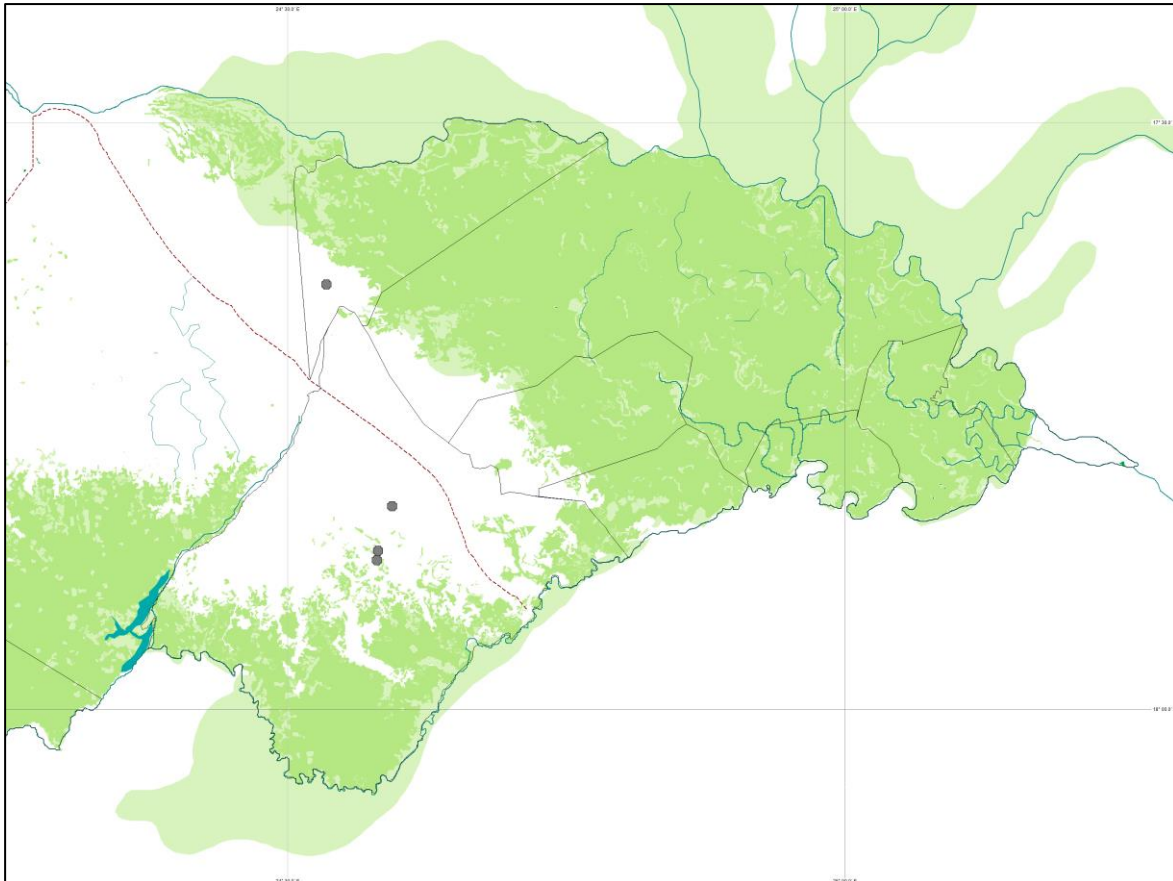


Figure 7 Sightings of giraffe

Giraffe sightings were concentrated in Salambala Conservancy. The isolated sighting in the north was outside the Rooikat survey strata.

2.2.5. Hippopotamus

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	48	15	0	181.3	15 - 135	6.68
Rooikat SE	98	41	0	68.7	41 - 165	7.83
Rooikat N	88	27	0	131.6	27 - 205	11.23
Survey Overall	234	83	0	67.2	83 - 391	8.51

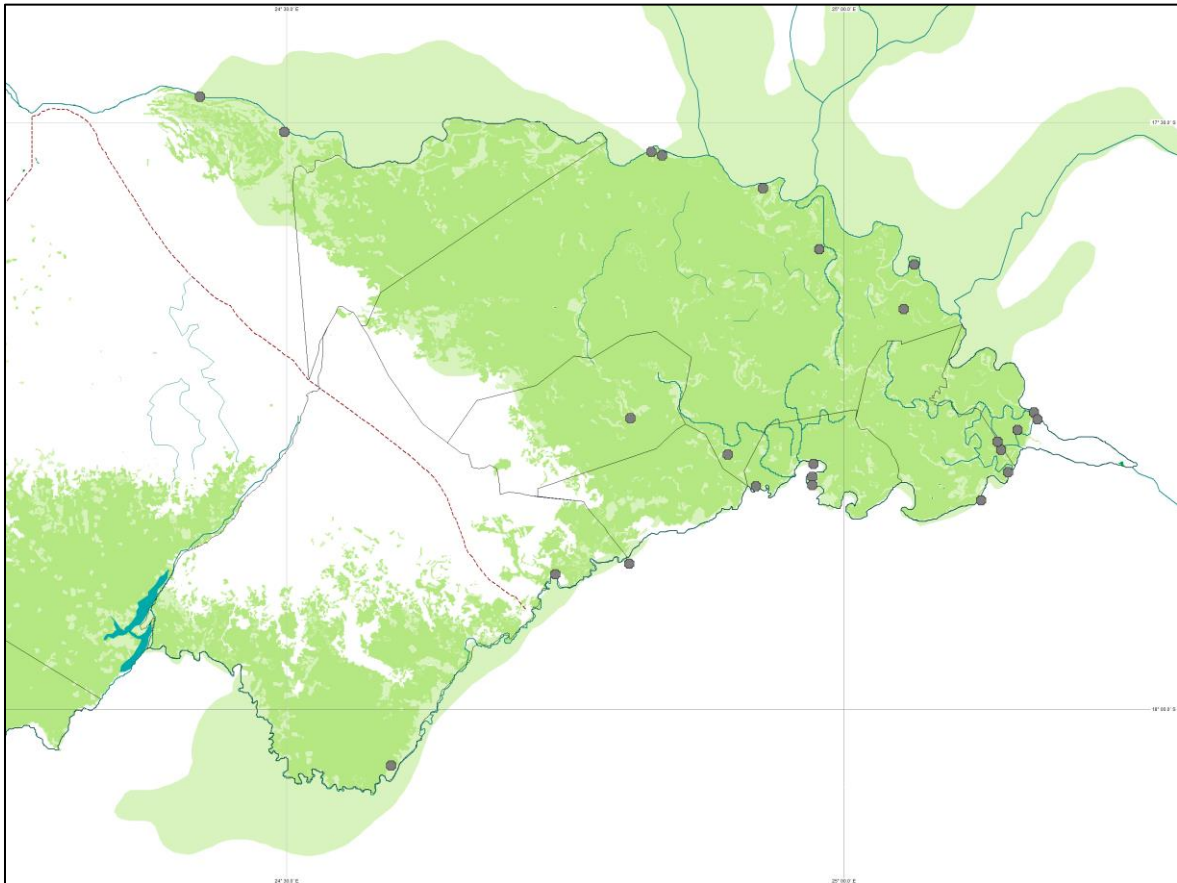


Figure 8 Sightings of hippo

2.2.6. Impala

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	269	84	0	98.5	84 - 534	37.49
Rooikat SE	141	58	80	135.8	58 - 332	11.3
Rooikat N	3	1	0	187.3	1 - 10	0.42
Survey Overall	413	143	80	78.2	143 - 736	15.02

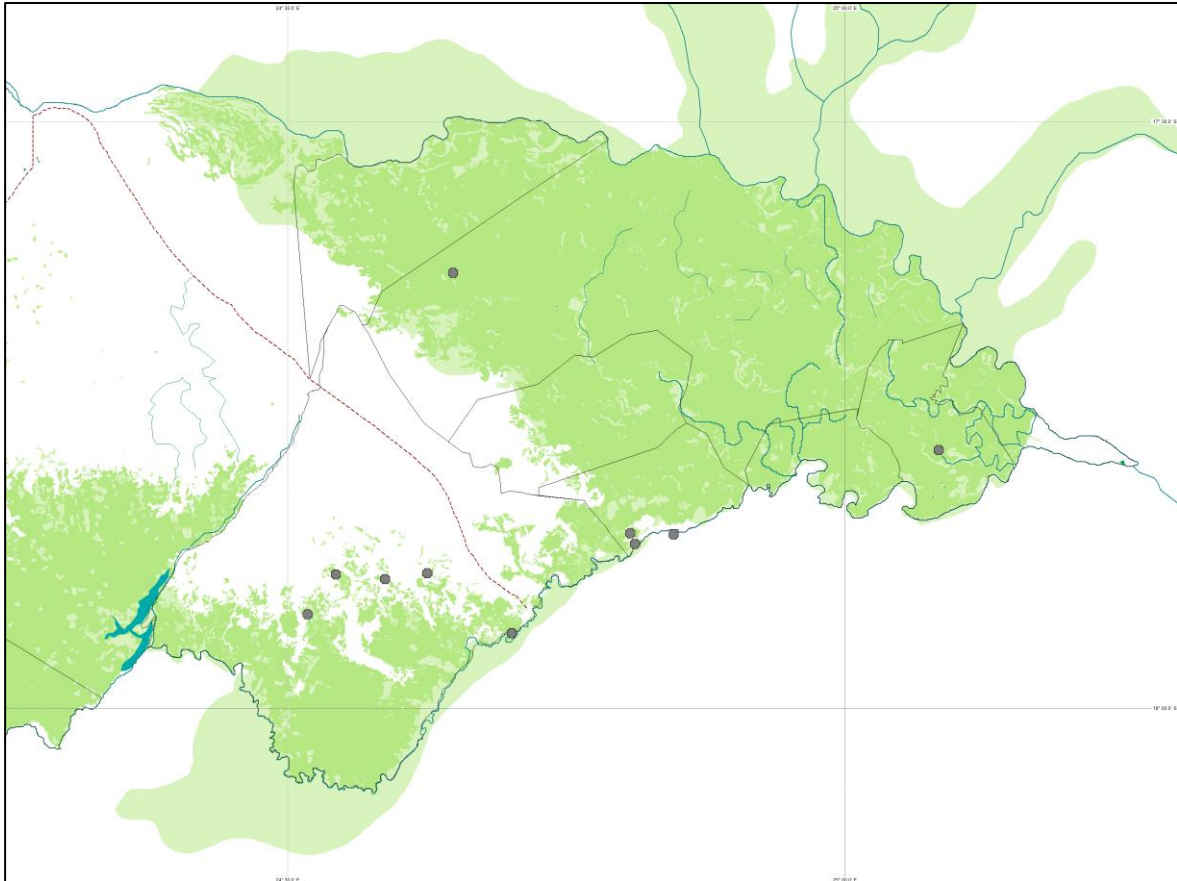


Figure 9 Sightings of impala

2.2.7. Kudu

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	36	11	0	92.6	11 - 68	4.95
Rooikat SE	0					
Rooikat N	0					
Survey Overall	36	11	0	91.5	11 - 68	1.29

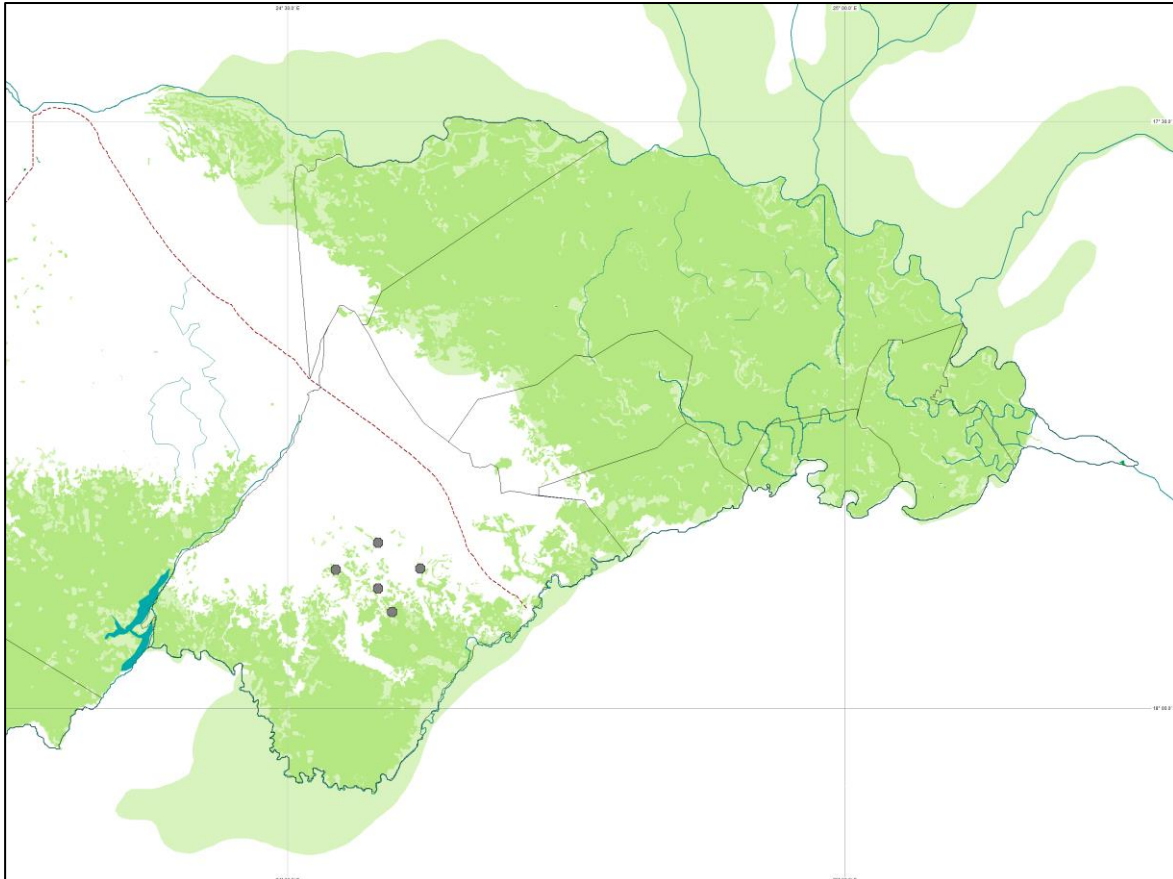


Figure 10 Sightings of kudu

The group of sightings picks out the wildlife management zone of Salambala Conservancy. This was the only area in which they were seen.

2.2.8. Lechwe

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	0					
Rooikat SE	46	20	0	149.3	20 - 114	3.69
Rooikat N	0					
Survey Overall	46	20	0	147.8	20 - 114	1.67

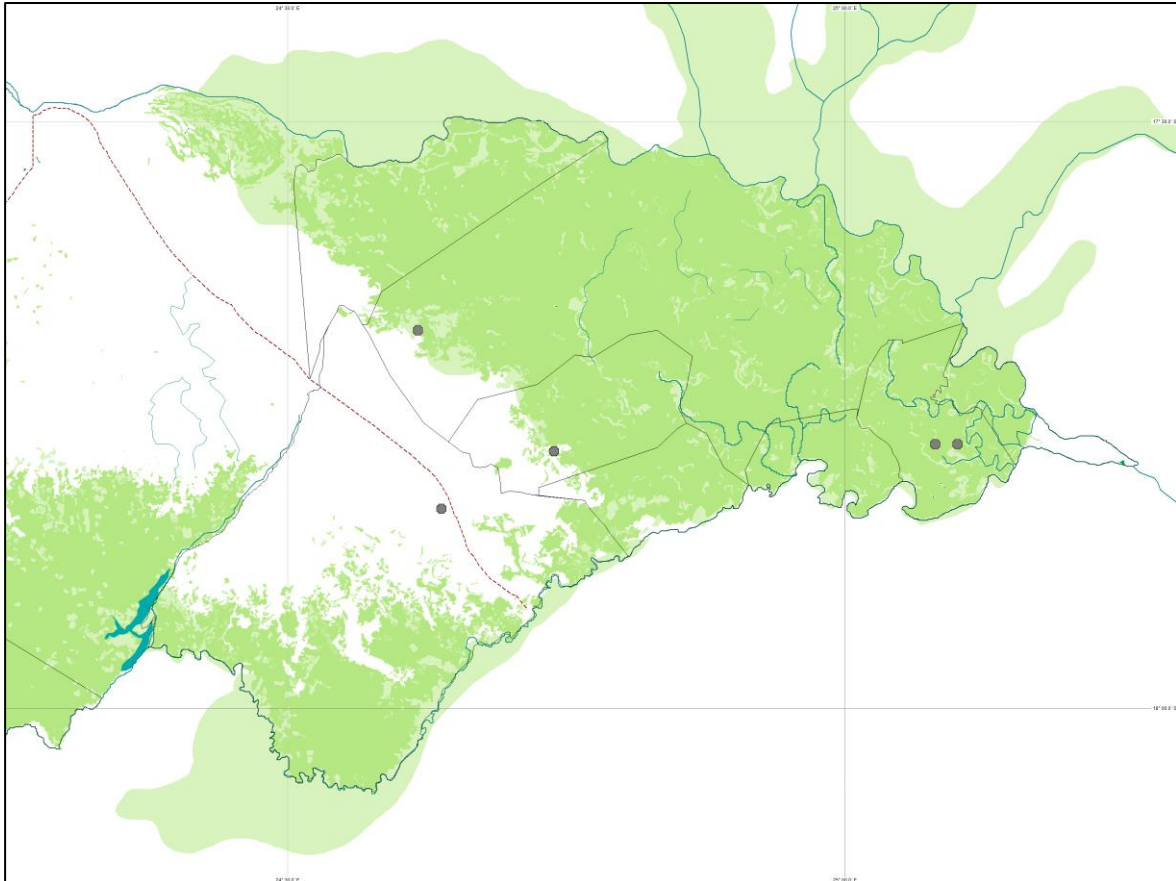


Figure 11 Sightings of lechwe

2.2.9. Reedbuck

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	3	1	0	182.8	1 - 9	0.46
Rooikat SE	0					
Rooikat N	10	3	0	137.1	3 - 24	1.26
Survey Overall	13	4	0	110.2	4 - 28	0.48

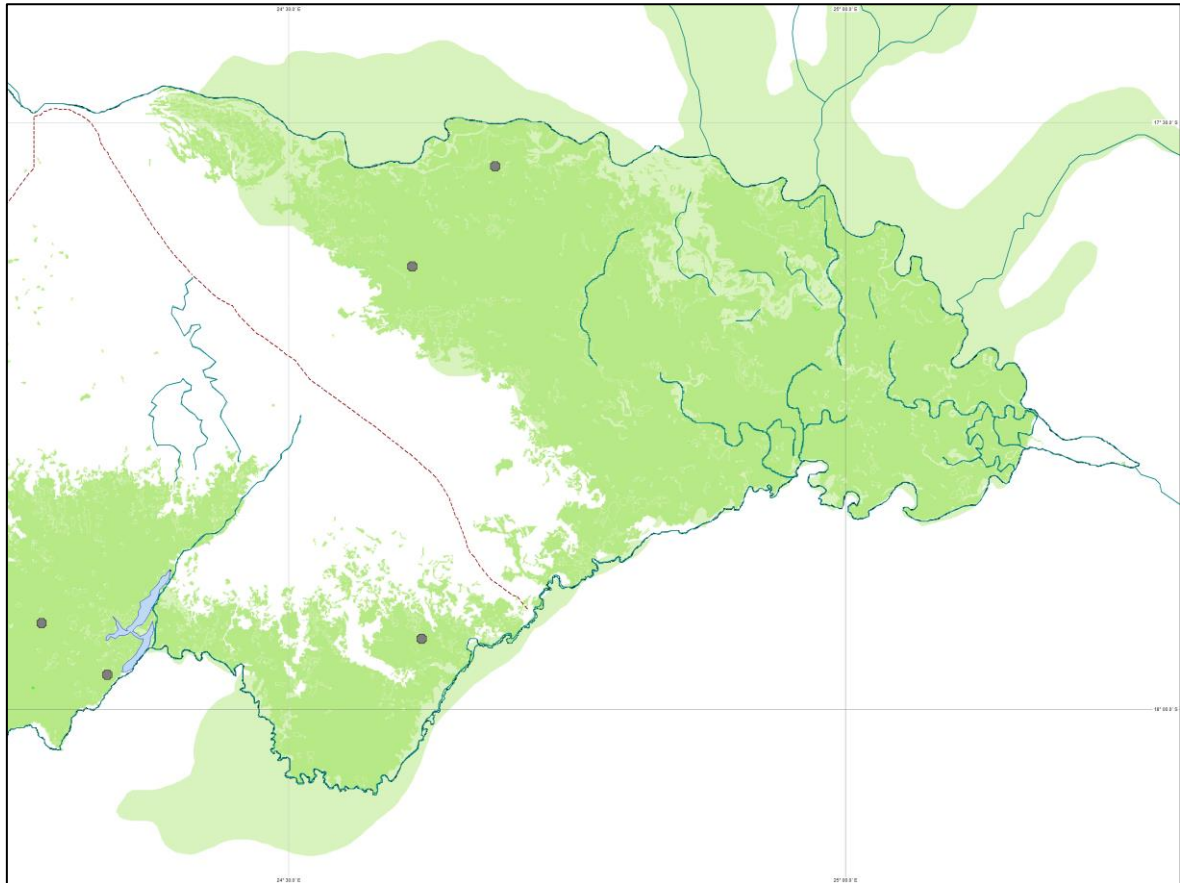


Figure 12 Sightings of reedbuck

2.2.10. Sable

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	26	8	0	181.3	8 - 72	3.57
Rooikat SE	0					
Rooikat N	0					
Survey Overall	26	8	0	179.2	8 - 71	0.93

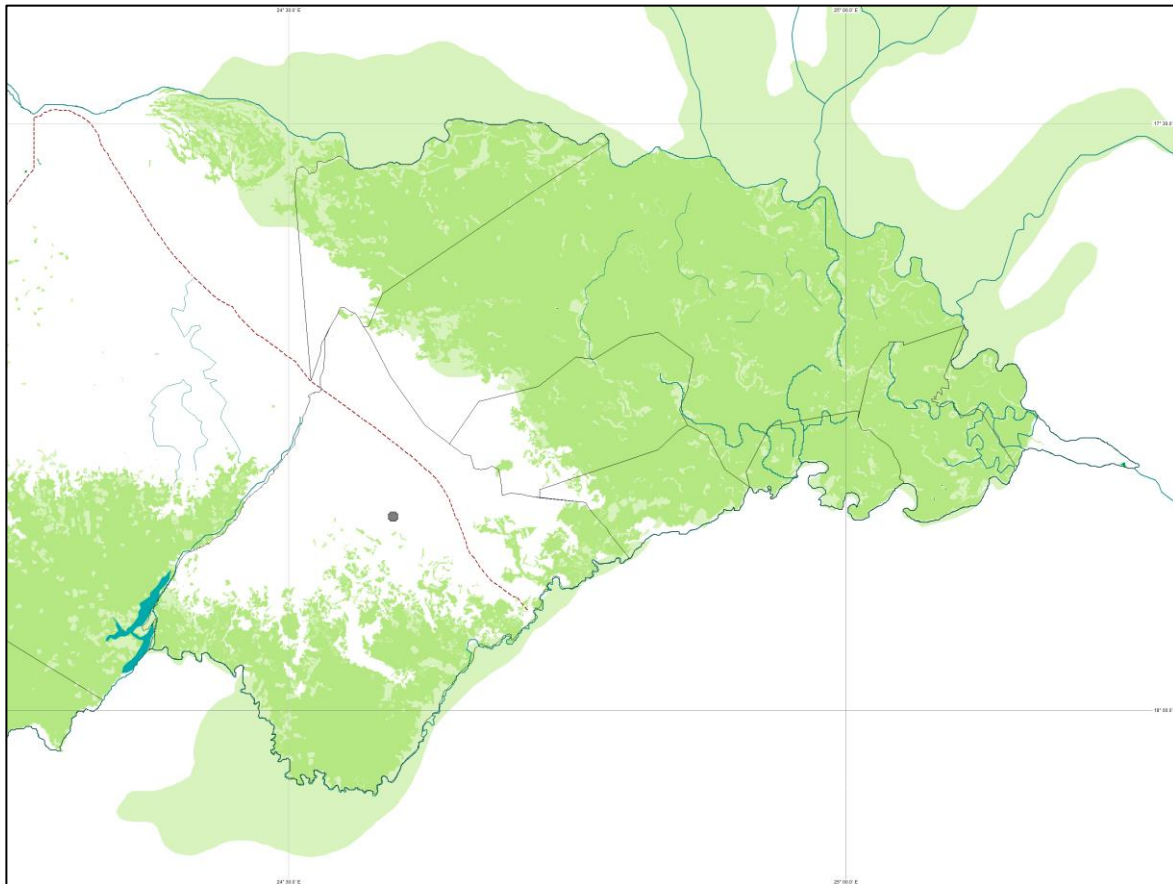


Figure 13 Sightings of sable

The one sighting of sable was in Salambala Conservancy.

2.2.11. Warthog

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	32	10	0	136.4	10 - 75	4.45
Rooikat SE	12	5	0	187.1	5 - 35	0.99
Rooikat N	56	17	0	147.1	17 - 138	7.11
Survey Overall	100	32	0	93.9	32 - 194	3.64

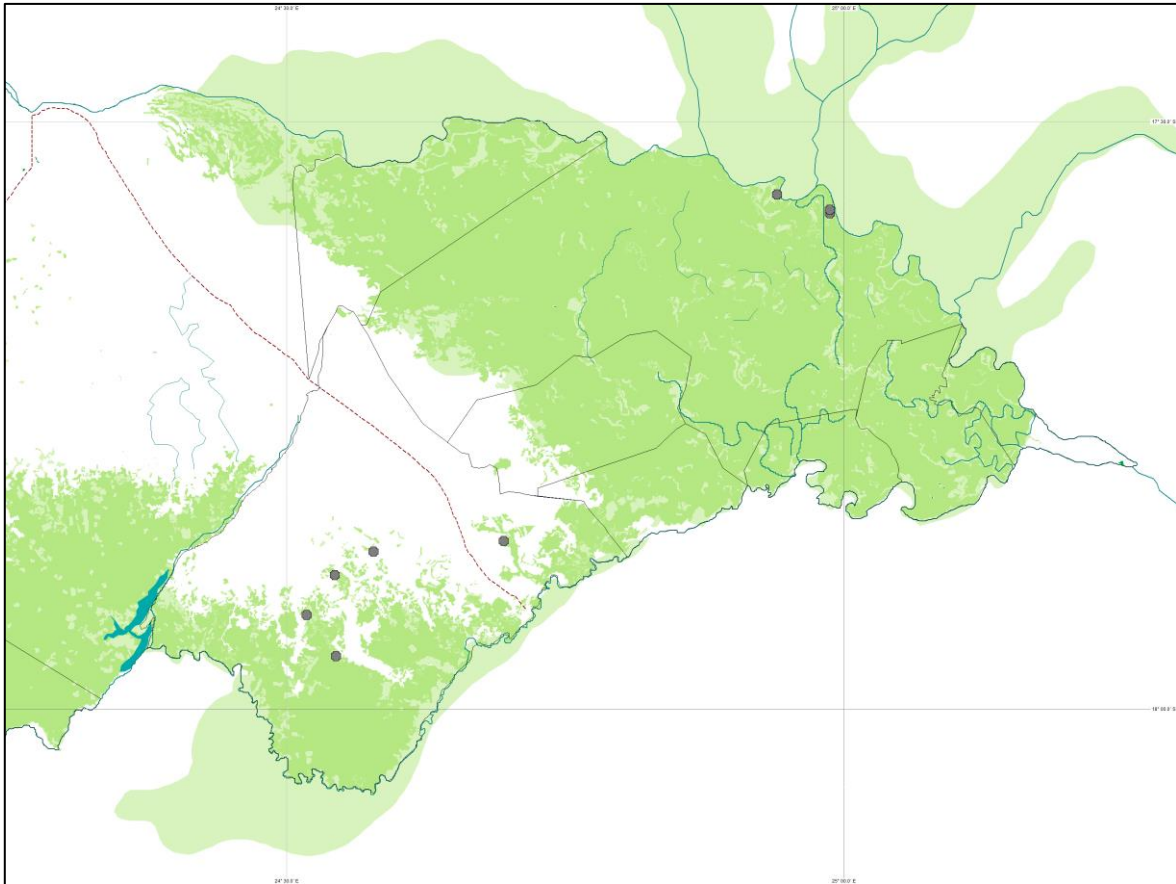


Figure 14 Sightings of warthog

2.2.12. Waterbuck

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	0					
Rooikat SE	7	3	0	186.8	3 - 21	0.58
Rooikat N	0					
Survey Overall	7	3	0	184.9	3 - 21	0.26

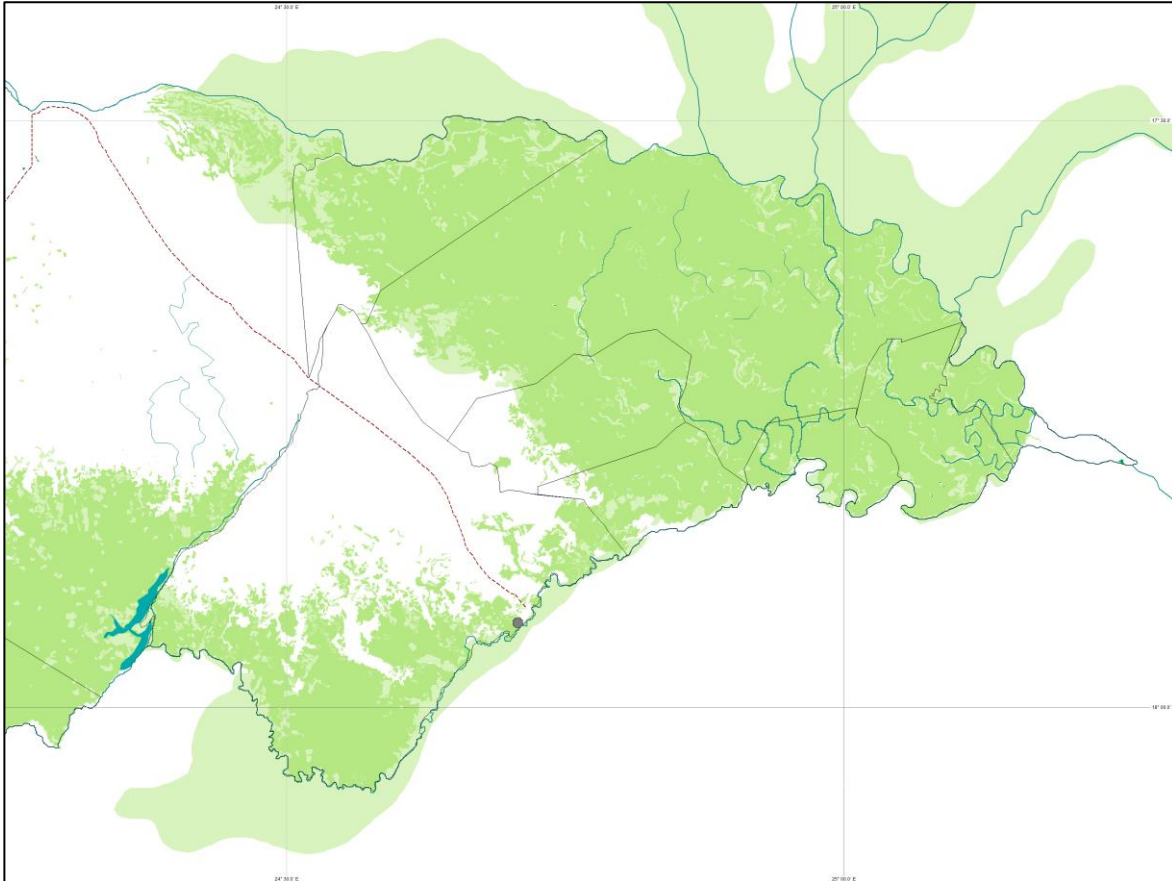


Figure 15 Sightings of waterbuck

2.2.13. Wildebeest

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	792	248	126	119.5	248 - 1738	110.29
Rooikat SE	105	45	0	136.8	45 - 249	8.44
Rooikat N	171	55	4	191.2	55 - 499	21.75
Survey Overall	1068	348	130	93.5	348 - 2067	38.83

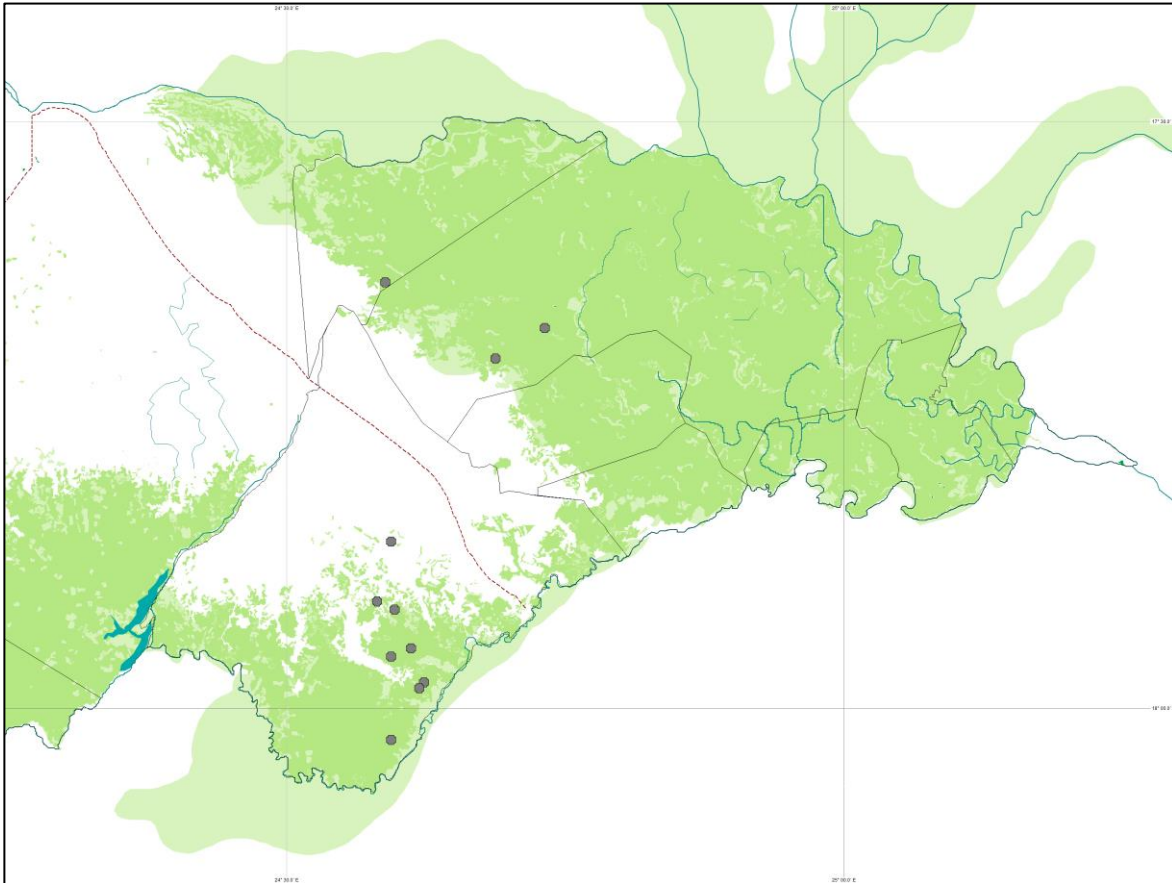


Figure 16 Sightings of wildebeest

2.2.14. Crocodile

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	0					
Rooikat SE	48	20	4	65.9	20 - 79	3.84
Rooikat N	3	1	0	186.9	1 - 9	0.42
Survey Overall	51	21	4	62.1	21 - 83	1.86

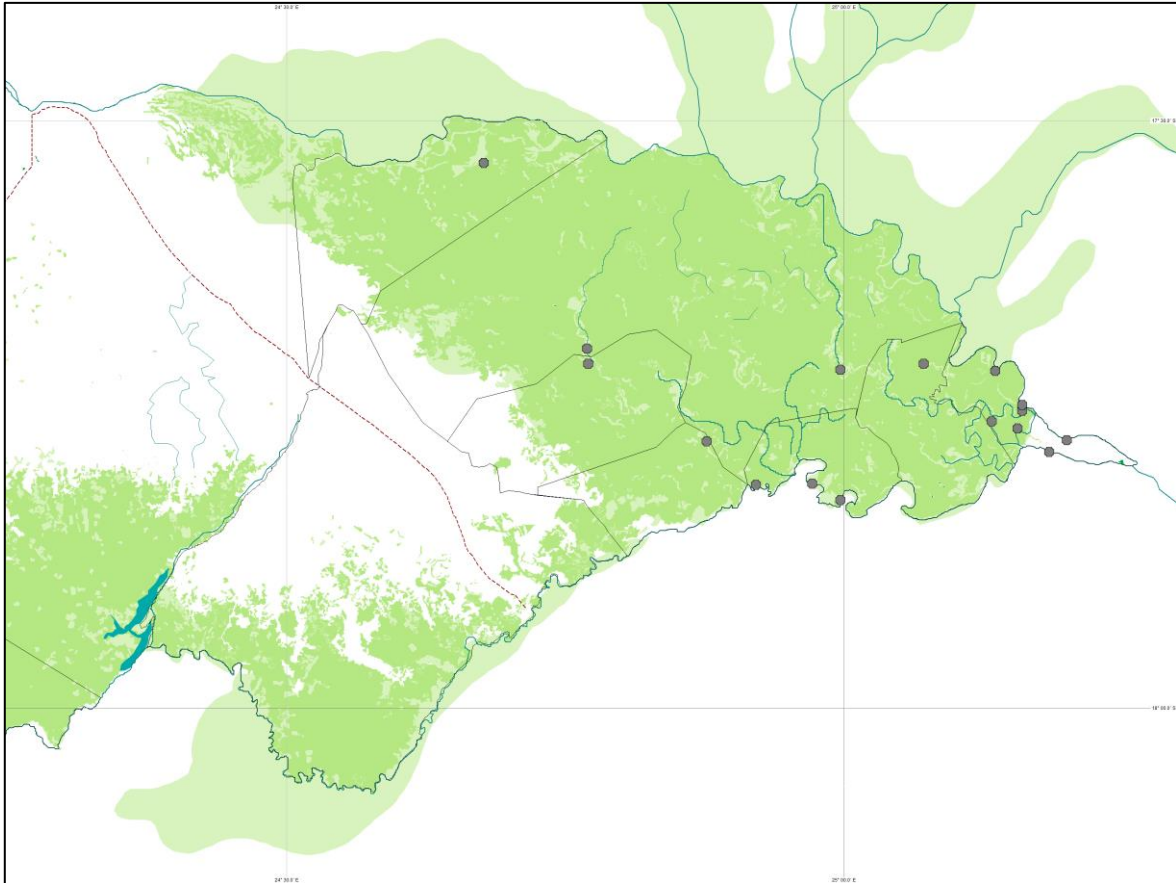


Figure 17 Sightings of crocodile

2.2.15. Ground Hornbill

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	0					
Rooikat SE	2	1	0	189.2	1 - 7	0.2
Rooikat N	0					
Survey Overall	2	1	0	187.2	1 - 7	0.09

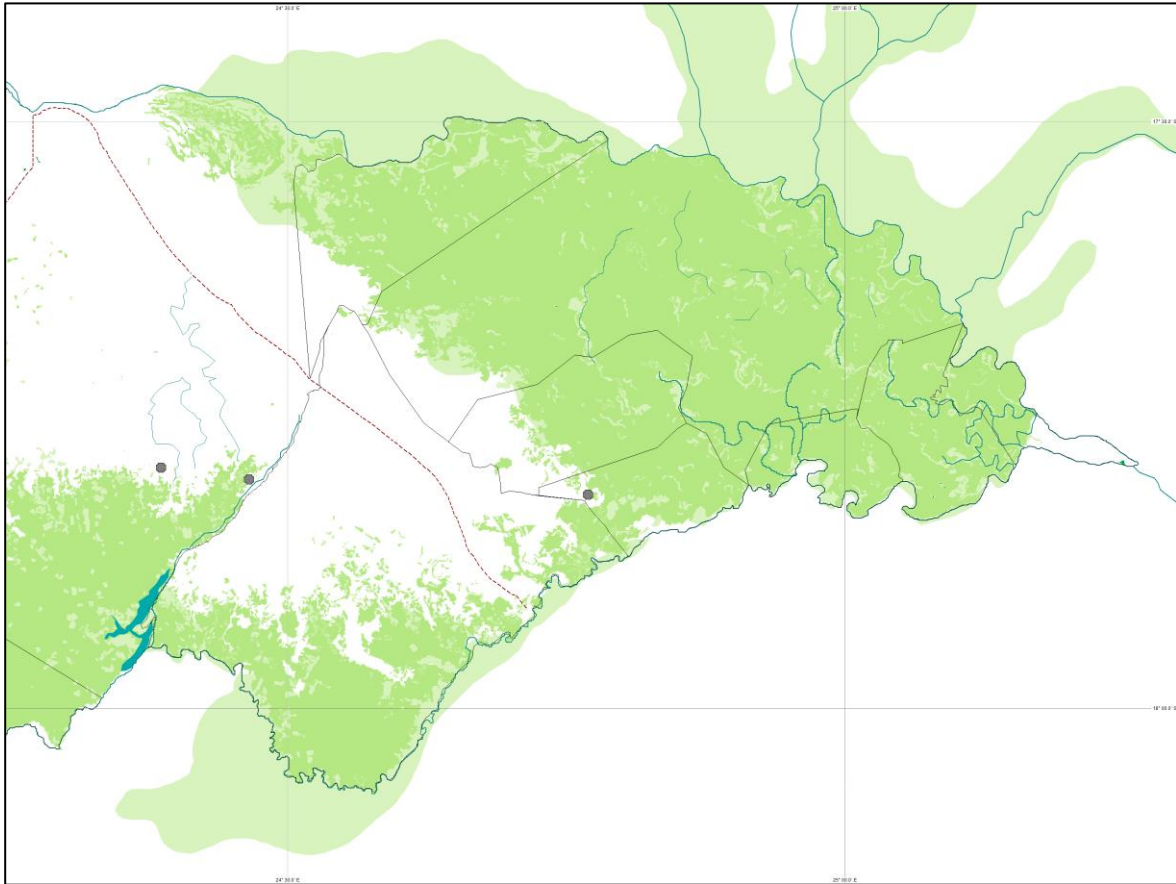


Figure 18 Sightings of ground hornbill

2.2.16. Ostrich

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Rooikat SW	0		1			
Rooikat SE	0					
Rooikat N	3	1	0	191.5	1 - 10	0.42
Survey Overall	3	1	1	187.1	1 - 9	0.12

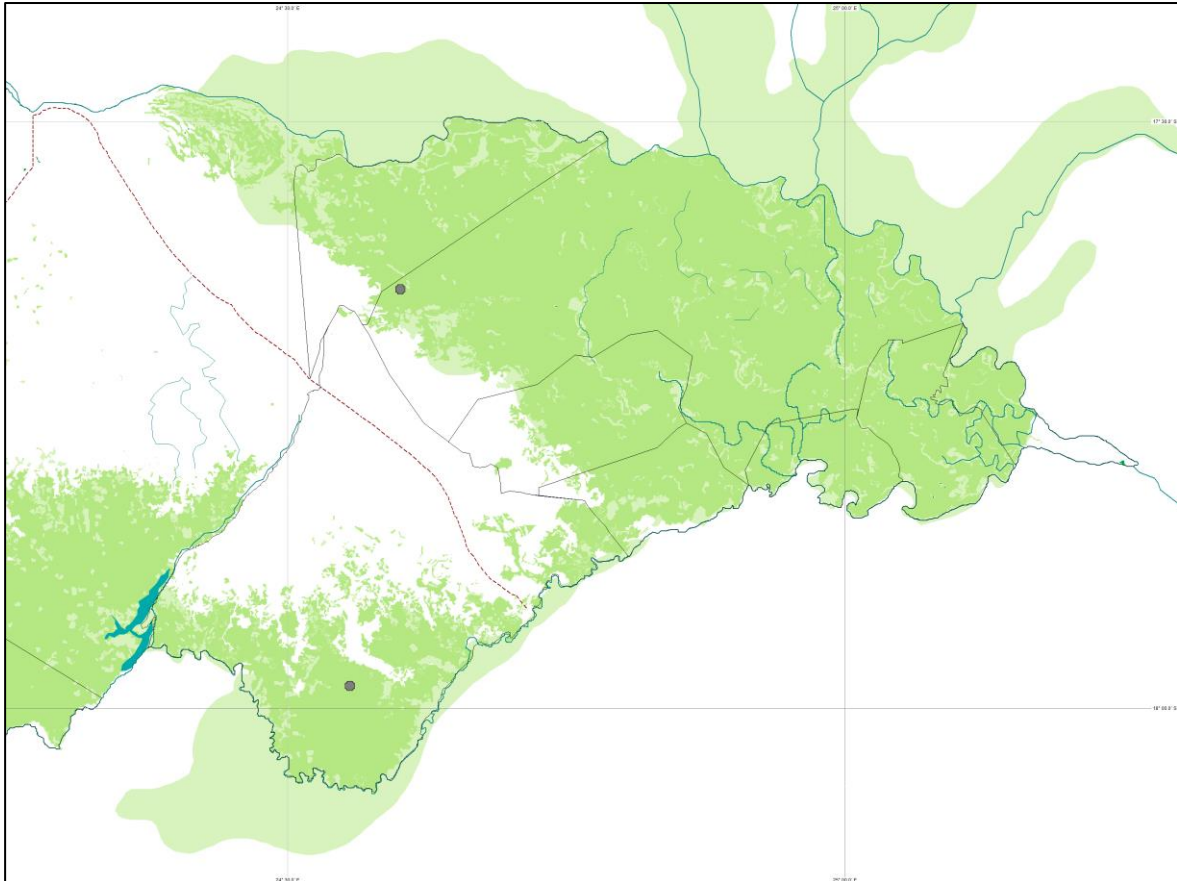


Figure 19 Sightings of ostrich

2.2.17. Livestock

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Domestic Pigs						
Rooikat SW	0					
Rooikat SE	33	14	0	134.5	14 - 77	2.63
Rooikat N	100	31	0	140.5	31 - 240	12.67
Pigs Overall	133	45	0	108.5	45 - 277	4.82
Horse						
Rooikat SW	3	1	0	181.4	1 - 9	0.46
Rooikat SE	0					
Rooikat N	0					
Horses Overall	3	1	0	179.3	1 - 9	0.12
Sheep and/or Goats						
Rooikat SW	702	218	0	62.1	266 - 1138	97.77
Rooikat SE	327	137	18	71.8	137 - 562	26.28
Rooikat N	187	58	0	81.0	58 - 338	23.69
Shoats Overall	1216	413	18	42.0	705 - 1727	44.2
Cattle						
Rooikat SW	9317	2900	1274	38.9	5694 - 12940	1297.65
Rooikat SE	25350	10680	8346	21.6	19877 - 30824	2036.17
Rooikat N	25962	8025	4516	16.4	21697 - 30228	3294.71
Cattle Overall	60630	21605	14136	12.7	52913 - 68346	2203.92

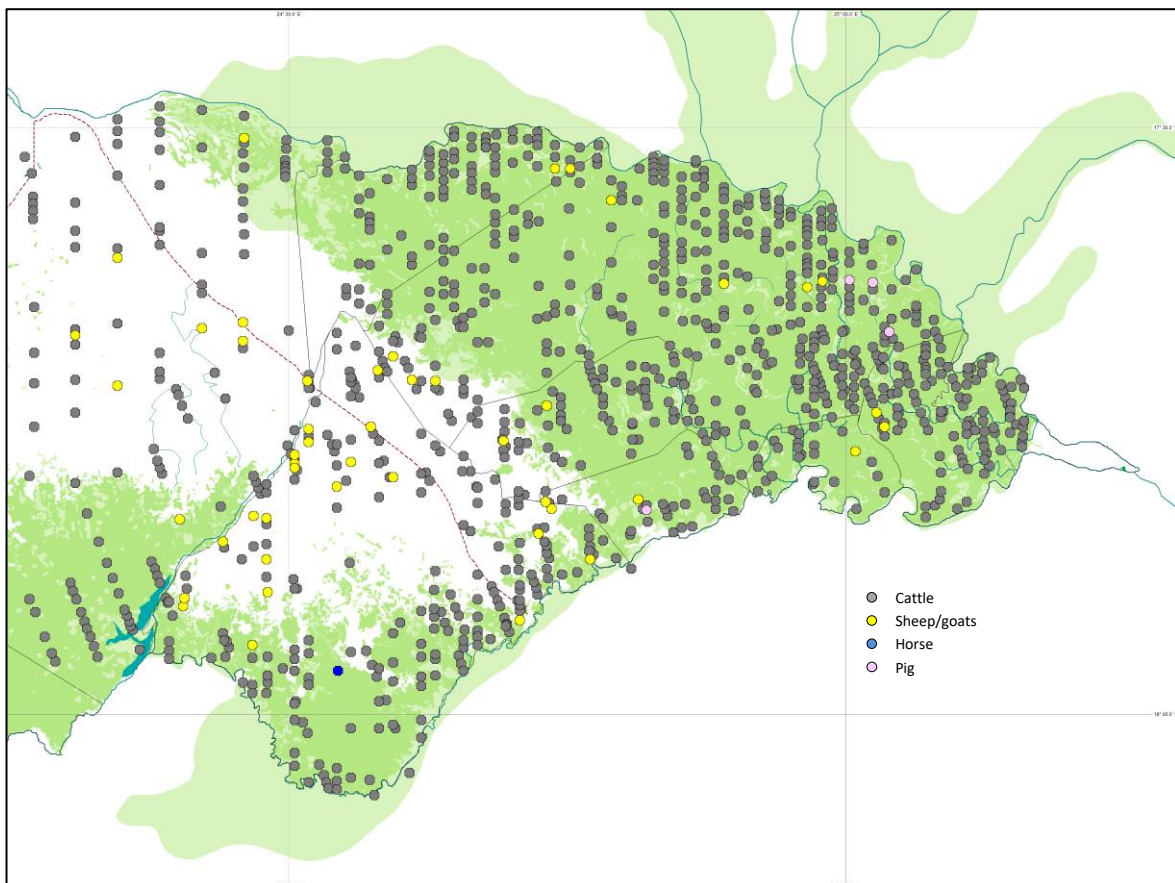


Figure 20 Sightings of domestic livestock

2.2.18. Carcasses other than elephants

	Pop. Est.	No. in	No. out	PRP %	95% Range	No./ 100km ²
Carcass 1						
Rooikat SW	0					
Rooikat SE	7	3	0	141.7	3 - 18	0.58
Rooikat N	3	1	0	193.3	1 - 9	0.4
Carcass 1 Overall	10	4	0	113.4	4 - 22	0.38
Carcass 2						
Rooikat SW	3	1	0	196.5	1 - 10	0.46
Rooikat SE	5	2	0	134.6	2 - 11	0.38
Rooikat N	0					
Carcass 2 Overall	8	3	0	111.8	3 - 17	0.29
Carcass 3						
Rooikat SW	0					
Rooikat SE	5	2	0	133.6	2 - 11	0.37
Rooikat N	0					
Carcass 3 Overall	5	2	0	132.2	2 - 11	0.17
Carcass 4						
Rooikat SW	0					
Rooikat SE	14	6	0	75.8	6 - 25	1.13
Rooikat N	3	1	0	186.9	1 - 9	0.42
Carcass 4 Overall	17	7	0	69.9	7 - 30	0.63

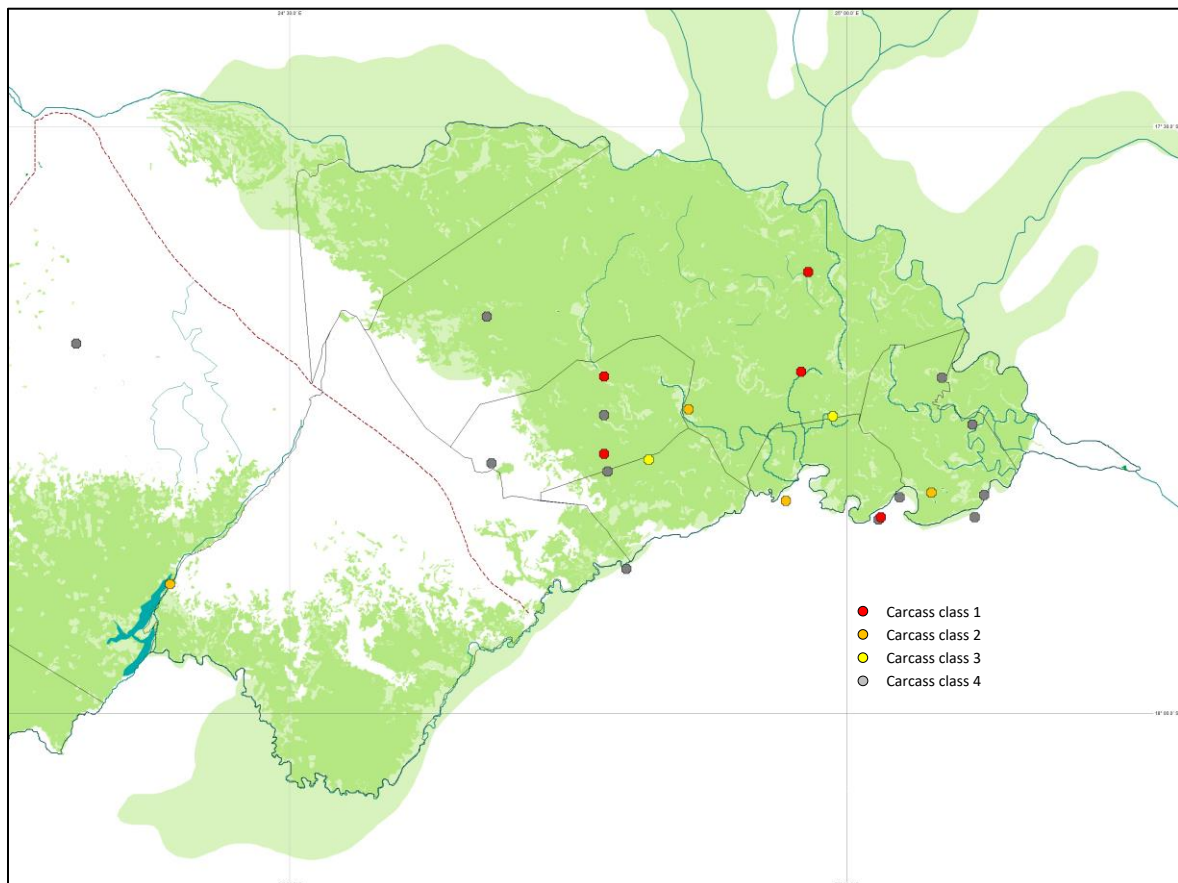


Figure 21 Sightings of carcasses other than elephants

2.2.19. Other Observations – human activity and settlement

Logging was seen in nine locations in Zambezi region on this survey. These were widely spread east of the Kwando river.

Human settlements are concentrated along the roads through the region as well as near the rivers. Fields and cattle posts are widely spread throughout the region.

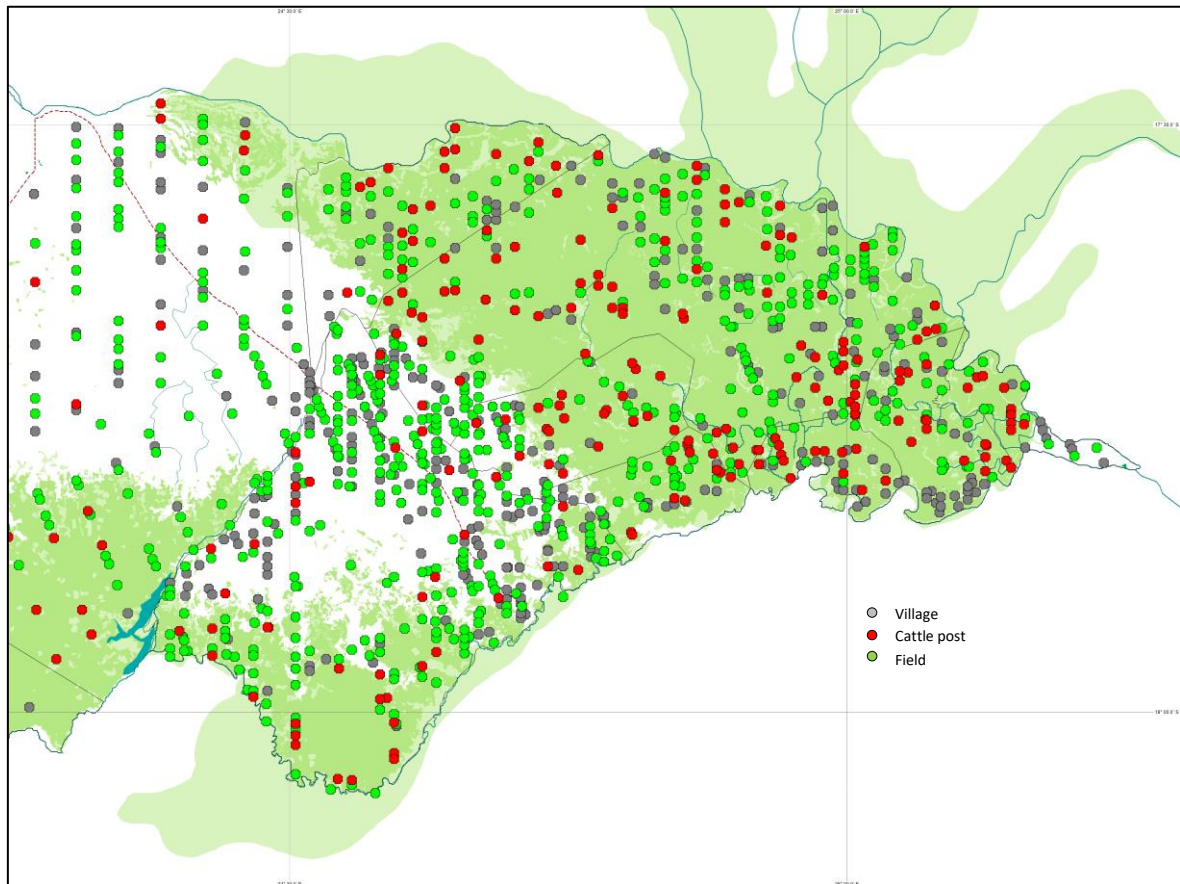


Figure 22 Sightings of villages, cultivation and cattle posts 2019

2.2.20. Other Observations – fishing activities

Canoes, fish traps and nets and fishing camps were seen on all water bodies of eastern Zambezi region. Most of the canoes were lying on land that is seasonally flooded.

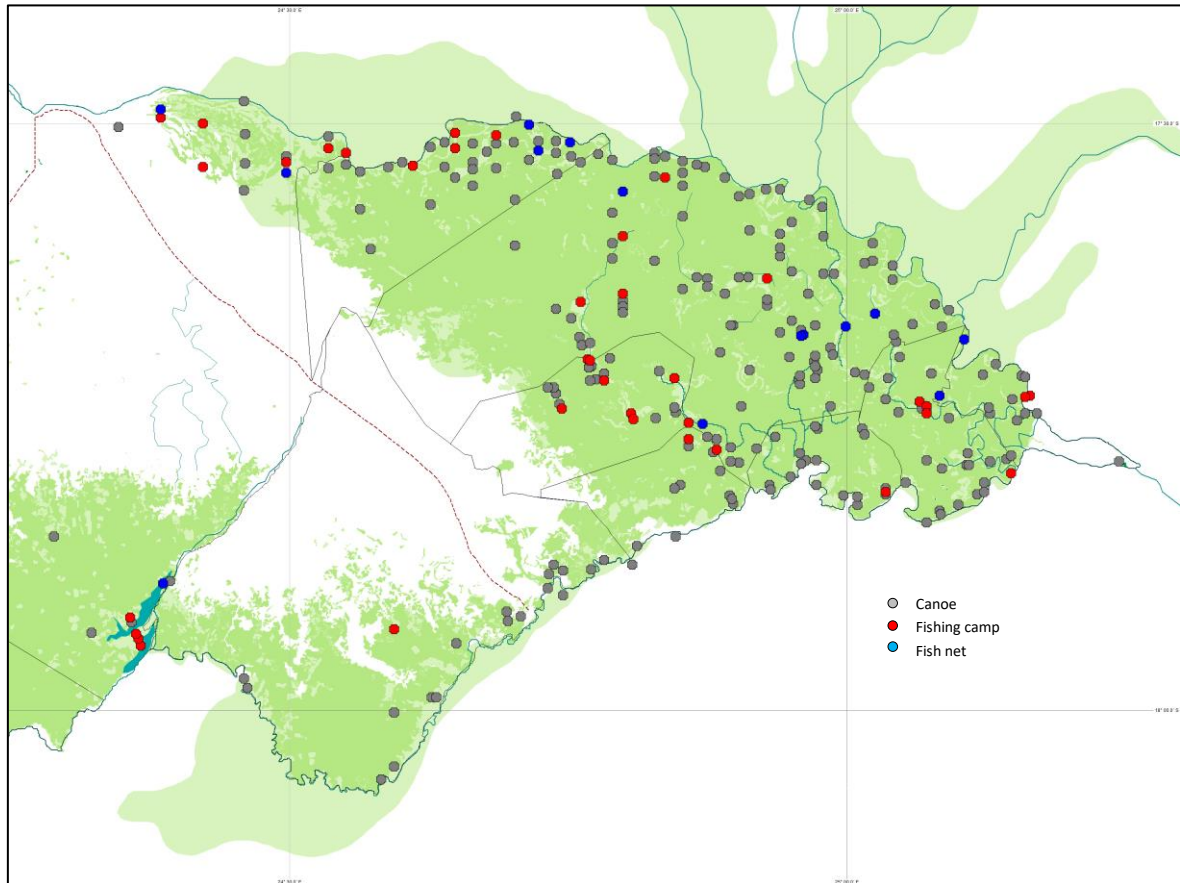


Figure 23 Sightings of fishing activities 2019

3. REFERENCES

- Craig G.C. 2011. *Countrywide survey of elephants in Namibia: draft report*. Report to the Ministry of Environment and Tourism, Namibia
- Craig G.C. 2012. *Monitoring the illegal killing of elephants: aerial survey standards for the MIKE Programme. Version 2.0*. CITES MIKE programme. Nairobi
- Craig G.C. & D. St.C. Gibson 2013. *Aerial survey of elephants and other wildlife in the Caprivi May/June 2013*. Report to the Ministry of Environment and Tourism, Namibia
- Craig G.C. & D. St.C. Gibson 2014. *Aerial survey of elephants and other wildlife in the Zambezi Region September/October 2014*. Ministry of Environment and Tourism, Namibia
- Douglas-Hamilton I. & A. Hillman 1981. *Elephant carcasses and skeletons as indicators of population trends in low-level aerial survey technique*. ILCA Monograph.
- Douglas-Hamilton I. & A. Burrell 1991. Using carcass ratios to determine trends. In: *Proceedings of the International symposium on African Wildlife: Research and Management*.
- Gibson D. St.C. & G.C. Craig 2015. *Aerial survey of elephants and other wildlife in the Zambezi Region September/October 2015*. WWF. Ministry of Environment and Tourism, Namibia
- Jolly G.M. 1969. Sampling methods for aerial censuses of wildlife populations. *E. Afr. Agricultural & Forestry Journal* - special issue: 46 -49.
- Norton Griffiths M. 1978. *Counting Animals*. Handbook No. 1, African Wildlife Foundation, Nairobi, Kenya. *Agricultural & Forestry Journal* - special issue: 46 -49.

APPENDIX I: METHODS

Methods followed CITES aerial survey standards using stratified systematic transect sampling (Norton Griffiths, 1978) with analysis using Jolly's method for unequal size sampling units (Jolly, 1969).

a. Survey design

This survey comprised part of a larger coverage of Zambezi Region from Mahango National Park west of the Kavango River to the confluence of the Zambezi and Chobe Rivers. Three additional strata (Rooikat North, South-east and South-west) in the east of Zambezi region were included to overlay the basic strata for more intensive coverage. The south east and south west strata were flown together but separated for analysis to accommodate the overlap between Rooikat South and East Zambezi south.

b. Sampling intensity

Pars of the Zambezi Region strata were covered more than once in order to increase the sampling intensity. The Rooikat strata were sampled twice.

In order to achieve sampling intensities of over 10%, it would be necessary to space transects as little as 1.3 km apart. With strip widths of 200m per side and a 100m dead zone under the aircraft, this would leave a distance between transects of 800m outside the strip markers. Any deviation from track could cause double counting, as well as disturbing animals on adjacent transects, which would violate the assumptions of the method of calculating precision. It was decided, therefore, to conduct multiple independent surveys of the relevant strata at 10% sampling intensity. The estimated numbers of animals were calculated as a mean of the individual estimates. The combined variances were calculated as $V = \Sigma v/n^2$ (n is the number of surveys).

c. Selection of transects

Transects were evenly spaced according to the required sampling intensity from a randomly chosen start point and oriented at right angles to major features (eg rivers) in each stratum, as far as possible (Fig. 24).



Figure 24 Transects selected 2019

d. Data collection

The aircraft, a Cessna 182 was flown at a nominal height of 300 feet above ground level along the transects. Height was maintained using a Lightware SF11 laser rangefinder fitted in the starboard wing of the aircraft.

Data from the rangefinder was interpreted through a Vulcan Flightlogger. Logging data was started and ended at the beginning and end of each transect respectively.

All incoming height, speed and location information was recorded for use in later analyses along with a time-stamp for each record. Accurate navigation along each transect was achieved using an ipad into which transect coordinates had also been up-loaded. The position of each sighting was “marked” in a Garmin 64S GPS.

Tracklogs of all flights were recorded in both Garmin GPS and the Vulcan Flightlogger.

Sampling strips were demarcated by rods attached to the lift struts on each side of the aircraft. These were calibrated for each observer by flying at varying heights across numbers marked 10m apart on a level airstrip. The observers called the inner and outer numbers seen between the rods. The difference between these numbers gave a distance that was adjusted for 300 ft a.g.l. and the mean used as the calibrated strip width for each observer.

Observers called out animals and other parameters seen from their fixed positions in the rear seats. They distinguished between sightings within and outside the sampling rods.

e. Searching rate

The searching rate (km^2/hr) was calculated for each transect and the mean for each stratum provided as an objective indication the survey quality.

f. Mapping wildlife distribution

The positions of the sightings were simply plotted on a map of the area without accounting for the relative numbers of animals per sighting or the sampling intensity at which the sighting was made.

g. Data analysis

Jolly's (1969) method for blocks of unequal size was used to calculate estimates of density and variance for each species in each stratum.

Overall estimates and variances were obtained from the sums of the stratum estimates and their variances.

h. Species and attributes recorded.

Carcasses were classified into four categories according to their estimated time since death ((Douglas-Hamilton & Hillman 1981; Douglas-Hamilton & Burrell 1991)). These classes were applied to carcasses of all species although they had been developed for elephants.

Sightings of all large wild mammals were recorded as were sightings of crocodiles, ostriches and ground hornbills. Observations of carnivores – jackals, lions and hyaenas – were recorded but these animals are difficult to see from the air and estimates of their numbers meaningless.

Observations of human activities included villages, fields, domestic livestock, fishing camps, boats and fish nets. Evidence of commercial logging was recorded. Bush fires were also noted.

APPENDIX II: RESULTS

The survey crew comprised R. Odendaal (pilot), C. Craig (front-seat recorder/coordinator), N. Chitemamuswe (left hand observer) and F. Muroki (right hand observer), M. Brassine (data capture/right hand observer/driver), T. Sirika (ground support/cook).

Supporting data indicating survey quality are given below. More details can be found in the report of the full Zambezi Region survey (Craig & Gibson 2019).

Track logs of the transects flown are shown in Fig. 25.

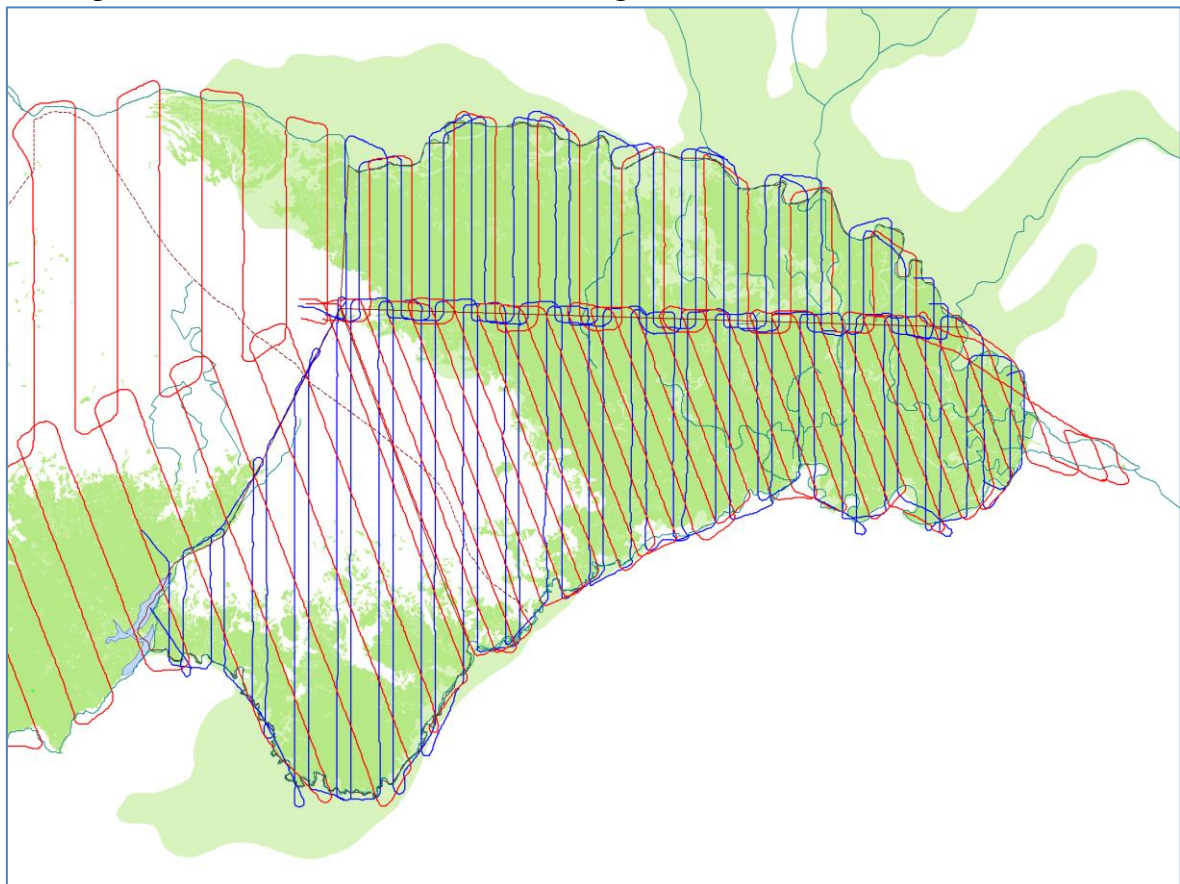


Figure 25 Tracks of flights 2019

a. Stratum statistics

Overall percentage sampling intensities (SI%) are presented in tables 1 and 2.

Table 1. Sampling intensities

Stratum	SI%
Rooikat North (ECNE, RN A, RN B)	30.91
Rooikat South East Salambala-Impalila (SAL A, SAL B, RSEA, RSEB)	42.22
Rooikat South West (ECSE, RSW A, RSW B)	31.12

Table 2. Stratum statistics:

Areas = km² ; No. trans = number of transects in stratum; SI% = sampling intensity; trans time = total flight time on transects; total length = total length of transects in km; ground speed = knots; search rate = km²/min

Stratum	Area	No. Trans	SI%	Trans time	Sample area	Total transect length	Mean ground speed	Search Rate
E Zambezi North E	788	14	10.08	1.11	78.12	191.9	102.8	1.17
Rooikat N A	788	15	10.13	1.05	79.81	193.7	99.3	1.27
Rooikat N B	788	15	10.70	1.07	84.29	205.5	104.1	1.31
Salambala/Impalila A	1245	15	10.63	1.90	131.16	319.3	90.6	1.15
Salambala/Impalila B	1245	15	10.99	1.77	134.60	327.7	99.8	1.27
Rooikat S A	1959	21	10.42	2.70	202.49	493.0	98.7	1.25
Rooikat S B	1959	21	10.18	2.63	198.77	495.1	101.5	1.26
E Zambezi South W	718	7	10.52	1.16	75.56	213.4	99.1	1.25

b. Calibration of strip widths

Calibrated strip widths for two teams were calculated as 410.72m (Muroki and Chitemamuswe) and 401.45m (Brassine and Chitemamuswe).

c. Maintenance of height

The target height was 300 feet above ground level (a.g.l.). The mean height flown for this survey was 301.61 feet a.g.l. 95% of heights were within a predicted 35 feet of this value.

	HEIGHT ft a.g.l.
<i>Mean</i>	<i>301.61</i>
<i>Variance</i>	<i>292.52</i>
<i>Std Deviation</i>	<i>17.10</i>

d. Flight speeds

Flying speed was kept to below 103 knots (190km/hour). The mean speeds and related statistics are presented in the following table and frequency histogram.

	SPEED knots
<i>Mean</i>	<i>101.66</i>
<i>Variance</i>	<i>25.82</i>
<i>Std Deviation</i>	<i>5.08</i>

Mean speed was slightly higher than that for the main Zambezi survey . The increase was made to enable the survey to be completed within the available time and budget.

APPENDIX III: RESULTS BY STRATUM

Estimates of numbers, densities and confidence limits

The following tables give the results for each stratum based on the numbers seen in the sample. SI refers to the sampling intensity for the stratum. Results for all species and attributes counted are given. Column 6, labelled PRP (Percent Relative Precision), is the 95% confidence interval expressed as a percentage of the estimate.

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

For species or attributes where no meaningful estimate can be given, only number seen is reported.

Where the overall result for a stratum is the result of separate coverages, the component results are given first. Table titles show which strata are combined into the results. This is summarised as follows:

STRATUM NAME	CODE
ROOIKAT SURVEY OVERALL:	
Rooikat North Mean:	
<i>East Zambezi North (eastern part)*</i>	ECNE
<i>Rooikat North A</i>	RNA
<i>Rooikat North B</i>	RNB
Rooikat Southwest Mean:	
<i>East Zambezi South (eastern part)*</i>	ECSE
<i>Rooikat South A (western part)</i>	RSWA
<i>Rooikat North B (western part)</i>	RSWB
Rooikat Southeast (Salambala-Impalila) Mean:	
<i>Salambala-Impalila A*</i>	SAL A
<i>Salambala-Impalila B*</i>	SAL B
<i>Rooikat South A (eastern part)</i>	RNA
<i>Rooikat South B (eastern part)</i>	RNB

* overlapping parts of Zambezi Survey

Rooiat Survey Area: 2751 km²

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
All Elephants	653	257	191	67530.9	78.6	257 - 1165	23.72
ElephantFamily	622	244	185	66768.6	81.9	244 - 1132	22.62
ElephantBull	30	13	6	133.7	75.6	13 - 53	1.1
EleCarcass 2	0	0	1	0	0	0 - 0	0
EleCarcass 3	10	4	0	54.3	140.3	4 - 25	0.38
EleCarcass 4	32	12	0	83	57	14 - 49	1.15
All E carcasses	42	16	1	133.6	54.5	19 - 65	1.52
Buffalo	394	170	1118	71222.5	133.8	170 - 920	14.31
Giraffe	26	8	1	190.5	106.2	8 - 53	0.93
Hippopotamus	234	83	0	6355	67.2	83 - 391	8.51
Impala	413	143	80	26804.9	78.2	143 - 736	15.02
Kudu	36	11	0	271.2	91.5	11 - 68	1.29
Lechwe	46	20	0	1180.9	147.8	20 - 114	1.67
Monkey		13					
Reedbuck	13	4	0	54.4	110.2	4 - 28	0.48
Sable	26	8	0	540	179.2	8 - 71	0.93
Warthog	100	32	0	2274.2	93.9	32 - 194	3.64
Waterbuck	7	3	0	45.5	184.9	3 - 21	0.26
Wildebeest	1068	348	130	256151.6	93.5	348 - 2067	38.83
Zebra	5713	2048	2414	1148910	37	3598 - 7828	207.67
Hyaena		1					
Jackal BB		2					
Crocodile	51	21	4	259.2	62.1	21 - 83	1.86
GroundHornbill	2	1	0	5.4	187.2	1 - 7	0.09
Ostrich	3	1	1	9.7	187.1	1 - 9	0.12
Saddlebill		2					
Pelican	353	150	15	111929.1	187.1	150 - 1013	12.83
Pig	133	45	0	5317.7	108.5	45 - 277	4.82
Horse	3	1	0	8.9	179.3	1 - 9	0.12
Cattle	60630	21605	14136	1.53E+07	12.7	52913 - 68346	2203.92
Sheep/goats	1216	413	18	67072.5	42	705 - 1727	44.2
OtherCarcass 1	10	4	0	35.5	113.4	4 - 22	0.38
OtherCarcass 2	8	3	0	20.7	111.8	3 - 17	0.29
OtherCarcass 3	5	2	0	9.6	132.2	2 - 11	0.17
OtherCarcass 4	17	7	0	38	69.9	7 - 30	0.63

ECNE : East Zambesi North (East part) Area: 788 km² Sampling Intensity: 10.075%

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
Hippopotamus	189	19	0	28170.6	192.3	19 - 551	23.93
Impala	10	1	0	84.8	200.4	1 - 30	1.26
Reedbuck	30	3	0	408.4	146.6	3 - 73	3.78
Warthog	50	5	0	2271.7	207.5	5 - 153	6.3
Zebra	2829	285	118	3660802	146.1	285 - 6962	359
Pig	169	17	0	27223.8	211.2	17 - 525	21.41
Cattle	26840	2704	888	1.37E+07	29.8	18830 - 34850	3406.09

RNA : Rooikat N A Area: 788 km² Sampling Intensity: 10.128%

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
Hippopotamus	39	4	0	497.6	121.1	4 - 87	5.01
Warthog	118	12	0	12724.8	204.2	12 - 360	15.04
Zebra	464	47	53	187016	199.9	47 - 1392	58.89
Crocodile	10	1	0	83.5	198.5	1 - 29	1.25
Ostrich	10	1	0	87.6	203.4	1 - 30	1.25
Cattle	24517	2483	1658	1.46E+07	33.4	16334 - 32700	3111.27
Sheep/goats	336	34	0	35440.7	120.3	34 - 739	42.6
OtherCarcass 4	10	1	0	83.5	198.5	1 - 29	1.25

RNB : Rooikat N B Area: 788 km² Sampling Intensity: 10.697%

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
EleCarcass 4	9	1	0	78.3	203	1 - 28	1.19
All E carcasses	9	1	0	78.3	203	1 - 28	1.19
Hippopotamus	37	4	0	1264.6	204	4 - 114	4.75
Wildebeest	514	55	4	236889.9	203	55 - 1558	65.25
Zebra	944	101	79	369127.6	138	101 - 2247	119.82
Pig	131	14	0	16249.3	208.9	14 - 404	16.61
Cattle	26530	2838	1970	1.19E+07	27.8	19146 - 33914	3366.78
Sheep/goats	224	24	0	15074.9	117.4	24 - 488	28.47
OtherCarcass 1	9	1	0	80.1	205.3	1 - 29	1.19

Rooiat N Mean(ECNE, RNA,RNB) Area: 788 km²

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./ 100km ²
EleCarcass 4	3	1	0	8.7	191.2	1 - 9	0.4
All E carcasses	3	1	0	8.7	191.2	1 - 9	0.4
Hippopotamus	88	27	0	3325.9	131.6	27 - 205	11.23
Impala	3	1	0	9.4	187.3	1 - 10	0.42
Reedbuck	10	3	0	45.4	137.1	3 - 24	1.26
Warthog	56	17	0	1666.3	147.1	17 - 138	7.11
Wildebeest	171	55	4	26321.1	191.2	55 - 499	21.75
Zebra	1412	433	250	468549.5	97.9	433 - 2795	179.24
Crocodile	3	1	0	9.3	186.9	1 - 9	0.42
Ostrich	3	1	0	9.7	191.5	1 - 10	0.42
Pig	100	31	0	4830.4	140.5	31 - 240	12.67
Cattle	25962	8025	4516	4461702	16.4	21697 - 30228	3294.71
Sheep/goats	187	58	0	5612.8	81.0	58 - 338	23.69
OtherCarcass 1	3	1	0	8.9	193.3	1 - 9	0.4
OtherCarcass 4	3	1	0	9.3	186.9	1 - 9	0.42

ECSE : East Zambesi South - E part Area: 718 km² Sampling Intensity: 10.523%

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
All Elephants	437	46	4	171233.4	195	46 - 1289	60.86
ElephantFamily	437	46	4	171233.4	195	46 - 1289	60.86
EleCarcass 3	10	1	0	80.9	195	1 - 28	1.39
EleCarcass 4	10	1	0	78.5	192	1 - 28	1.39
All E carcasses	19	2	0	150.8	133.1	2 - 44	2.65
Giraffe	29	3	1	712.6	192.8	3 - 83	4.04
Impala	485	51	0	97716	132.8	51 - 1128	67.55
Kudu	19	2	0	313.7	191.9	2 - 55	2.65
Warthog	67	7	0	3879.5	192.8	7 - 195	9.33
Wildebeest	1378	145	75	1664620	192.8	145 - 4035	191.92
Zebra	1521	160	190	805164	121.5	160 - 3369	211.84
Cattle	8553	900	539	1.12E+07	80.8	1646 - 15460	1191.23
Sheep/goats	133	14	0	5598.7	115.8	14 - 287	18.52

RSWA : Rooikat South West A Area: 718 km² Sampling Intensity: 10.418%

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
Giraffe	29	3	0	683.4	189.4	3 - 83	4.04
Hippopotamus	144	15	0	17086.1	189.4	15 - 417	20.06
Impala	58	6	0	2811.4	192	6 - 168	8.08
Kudu	38	4	0	1215	189.4	4 - 111	5.29
Sable	77	8	0	4860	189.4	8 - 222	10.72
Warthog	10	1	0	78.1	192	1 - 28	1.39
Wildebeest	605	63	31	301398.9	189.4	63 - 1750	84.26
Zebra	2544	265	106	1311133	93.9	265 - 4932	354.32
Jackal BB		2					
Ostrich	0	0	1	0	0	0 - 0	0
Cattle	10626	1107	254	9835102	61.6	4084 - 17168	1479.94
Sheep/goats	1325	138	0	289131.1	84.7	203 - 2446	184.54

RSWB : Rooikat South West B Area: 718 km² Sampling Intensity: 10.18%

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
EleCarcass 4	20	2	0	164.4	136.1	2 - 46	2.79
All E carcasses	20	2	0	164.4	136.1	2 - 46	2.79
Giraffe	20	2	0	318.8	189.6	2 - 57	2.79
Impala	265	27	0	58065.6	189.5	27 - 768	36.91
Kudu	49	5	0	912.3	128.3	5 - 112	6.82
Reedbuck	10	1	0	80.9	191	1 - 29	1.39
Warthog	20	2	0	318.6	189.5	2 - 57	2.79
Wildebeest	393	40	20	55662	125.2	40 - 885	54.74
Zebra	1090	111	305	435211.1	126.2	111 - 2467	151.81
Hyaena		1					
Horse	10	1	0	79.7	189.5	1 - 28	1.39
Cattle	8772	893	481	8543288	69.5	2675 - 14869	1221.73
Sheep/goats	648	66	0	133543.8	117.6	66 - 1411	90.25
OtherCarcass 2	10	1	0	93.4	205.2	1 - 30	1.39

Rooikat South West Mean (ECSE,RSWA,RSWB) Area: 718 km²

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
All Elephants	146	46	4	19025.9	189.0	46 - 421	20.29
ElephantFamily	146	46	4	19025.9	189.0	46 - 421	20.29
EleCarcass 3	3	1	0	9	189.0	1 - 9	0.44
EleCarcass 4	10	3	0	27	106.8	3 - 20	1.35
All E carcasses	13	4	0	35	91.7	4 - 25	1.79
Giraffe	26	8	1	190.5	107.5	8 - 53	3.57
Hippopotamus	48	15	0	1898.5	181.3	15 - 135	6.68
Impala	269	84	0	17621.4	98.5	84 - 534	37.49
Kudu	36	11	0	271.2	92.6	11 - 68	4.95
Reedbuck	3	1	0	9	182.8	1 - 9	0.46
Sable	26	8	0	540	181.3	8 - 72	3.57
Warthog	32	10	0	475.1	136.4	10 - 75	4.45
Wildebeest	792	248	126	224631.2	119.5	248 - 1738	110.29
Zebra	1718	536	601	283500.9	61.9	655 - 2782	239.31
Hyaena		1					
Jackal BB		2					
Ostrich	0	0	1	0	0	0 - 0	0
Horse	3	1	0	8.9	181.4	1 - 9	0.46
Cattle	9317	2900	1274	3291655	38.9	5694 - 12940	1297.65
Sheep/goats	702	218	0	47586	62.1	266 - 1138	97.77
OtherCarcass 2	3	1	0	10.4	196.5	1 - 10	0.46

RSEA : Rooikat South East A Area: 1245 km² Sampling Intensity: 10.418%

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
All Elephants	0	0	4	0	0	0 - 0	0
ElephantBull	0	0	4	0	0	0 - 0	0
EleCarcass 3	29	3	0	725.6	195.1	3 - 85	2.33
EleCarcass 4	10	1	0	78.2	192.1	1 - 28	0.8
All E carcasses	38	4	0	760.2	149.8	4 - 96	3.05
Buffalo	0	0	136	0	0	0 - 0	0
Hippopotamus	96	10	0	5642.7	163.2	10 - 253	7.71
Impala	307	32	0	87193.2	200.5	32 - 923	24.66
Waterbuck	29	3	0	728.2	195.5	3 - 85	2.33
Zebra	3254	339	324	1915241	88.7	367 - 6141	261.37
Crocodile	29	3	0	446.9	153.1	3 - 73	2.33
Pig	67	7	0	4121.8	199.3	7 - 201	5.38
Cattle	24795	2583	1266	3.41E+07	49.1	12611 - 36978	1991.57
Sheep/goats	269	28	0	23930.9	120.1	28 - 591	21.61
OtherCarcass 1	19	2	0	334.1	198.6	2 - 57	1.53
OtherCarcass 2	10	1	0	84.7	199.9	1 - 29	0.8
OtherCarcass 4	29	3	0	245.1	113.4	3 - 61	2.33

RSEB : Rooikat South East B

Area: 1245 km²

Sampling Intensity: 10.18%

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./ 100km ²
All Elephants	1257	128	41	711327.9	139.9	128 - 3017	100.96
ElephantFamily	1257	128	41	711327.9	139.9	128 - 3017	100.96
EleCarcass 4	20	2	0	149.7	129.9	2 - 45	1.61
All E carcasses	20	2	0	149.7	129.9	2 - 45	1.61
Hippopotamus	88	9	0	2998.5	129.2	9 - 203	7.07
Impala	255	26	30	59590.8	199.4	26 - 765	20.48
Warthog	49	5	0	2124.2	195.7	5 - 145	3.94
Wildebeest	147	15	0	19501.9	197.7	15 - 439	11.81
Zebra	3664	373	389	3089135	100.1	373 - 7330	294.3
Crocodile	98	10	0	2514	106.5	10 - 203	7.87
GroundHornbill	10	1	0	86.9	197.9	1 - 29	0.8
Cattle	27948	2845	2292	4.02E+07	47.3	14718 - 41177	2244.82
Sheep/goats	452	46	18	60153.4	113.2	46 - 963	36.31
OtherCarcass 1	10	1	0	91.3	202.9	1 - 30	0.8

SALA : Salambala-Impalila A Area: 1253 km² Sampling Intensity: 10.628 %

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./ 100km ²
All Elephants	452	48	52	51549.9	107.1	48 - 936	36.04
ElephantFamily	376	40	51	39451.8	112.5	40 - 800	30.04
ElephantBull	75	8	1	1382.1	105.3	8 - 155	6.01
Buffalo	847	90	935	653880.6	203.5	90 - 2570	67.58
Hippopotamus	169	18	0	8856.4	118.4	18 - 370	13.52
Lechwe	47	5	0	2018.1	203.5	5 - 143	3.75
Monkey	122	13	0	4093.2	111.5	13 - 259	9.76
Zebra	2183	232	276	1015635	98.4	232 - 4331	174.21
Crocodile	19	2	0	167.7	146.7	2 - 46	1.5
Cattle	26458	2812	1477	3.31E+07	46.3	14199 - 38717	2111.6
Sheep/goats	452	48	0	134043.3	172.8	48 - 1232	36.04
OtherCarcass 2	9	1	0	80	202.6	1 - 28	0.75
OtherCarcass 3	9	1	0	79	201.3	1 - 28	0.75
OtherCarcass 4	9	1	0	77.9	200	1 - 28	0.75

SALB : Salambala-Impalila B Area: 1253 km² Sampling Intensity: 10.99%

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
All Elephants	318	35	90	13201.1	76.5	75 - 562	25.42
ElephantFamily	273	30	89	13102.9	88.9	30 - 516	21.78
ElephantBull	45	5	1	757.1	128.2	5 - 104	3.63
EleCarcass 2	0	0	1	0	0	0 - 0	0
EleCarcass 4	45	5	0	528.8	107.2	5 - 94	3.63
All E carcasses	45	5	1	528.8	107.2	5 - 94	3.63
Buffalo	728	80	47	485679.2	203	80 - 2205	58.09
Hippopotamus	36	4	0	593.1	141.9	4 - 88	2.9
Impala	0	0	50	0	0	0 - 0	0
Lechwe	136	15	0	16876.2	201.8	15 - 412	10.89
Wildebeest	273	30	0	63687	196	30 - 808	21.78
Zebra	1228	135	574	329742.3	99.1	135 - 2446	98.03
Crocodile	45	5	4	870.8	137.5	5 - 108	3.63
Pig	64	7	0	3675.3	201.8	7 - 192	5.08
Cattle	22201	2440	3311	1.32E+07	34.6	14512 - 29889	1771.79
Sheep/goats	136	15	0	3851.9	96.4	15 - 268	10.89
OtherCarcass 3	9	1	0	74.8	201.5	1 - 27	0.73
OtherCarcass 4	18	2	0	136.2	136	2 - 43	1.45

Rooikat SE Salambala-Impalila Mean (SALA, SALB, RSEA, RSEB) Area: 1245 km²

SPECIES	Pop. est.	No. seen	No. Out	Variance	PRP%	95%Range	No./100km ²
All Elephants	507	211	187	48504.9	86.6	211 - 946	40.71
ElephantFamily	477	198	181	47742.7	91.4	198 - 912	38.29
ElephantBull	30	13	6	133.7	76.4	13 - 53	2.43
EleCarcass 2	0	0	1	0	0	0 - 0	0
EleCarcass 3	7	3	0	45.4	186.5	3 - 21	0.58
EleCarcass 4	19	8	0	47.3	73.4	8 - 32	1.5
All E carcasses	26	11	1	89.9	73	11 - 45	2.08
Buffalo	394	170	1118	71222.5	135.2	170 - 926	31.62
Hippopotamus	98	41	0	1130.7	68.7	41 - 165	7.83
Impala	141	58	80	9174	135.8	58 - 332	11.3
Lechwe	46	20	0	1180.9	149.3	20 - 114	3.69
Monkey	31	13	0	255.8	104.3	13 - 62	2.46
Warthog	12	5	0	132.8	187.1	5 - 35	0.99
Waterbuck	7	3	0	45.5	186.8	3 - 21	0.58
Wildebeest	105	45	0	5199.3	136.8	45 - 249	8.44
Zebra	2582	1079	1563	396859.6	48.6	1326 - 3838	207.42
Crocodile	48	20	4	250	65.9	20 - 79	3.84
GroundHornbill	2	1	0	5.4	189.2	1 - 7	0.2
Pig	33	14	0	487.3	134.5	14 - 77	2.63
Cattle	25350	10680	8346	7535565	21.6	19877 - 30824	2036.17
Sheep/goats	327	137	18	13873.7	71.8	137 - 562	26.28
OtherCarcass 1	7	3	0	26.6	141.7	3 - 18	0.58
OtherCarcass 2	5	2	0	10.3	134.6	2 - 11	0.38
OtherCarcass 3	5	2	0	9.6	133.6	2 - 11	0.37
OtherCarcass 4	14	6	0	28.7	75.8	6 - 25	1.13

