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Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

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The opinions expressed in this report are those of the authors and do not necessarily represent those of The Great Elephant Census, Paul G. Allen, or the Zimbabwe Parks and Wildlife Management Authority

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Summary

Elephants and other large herbivores, wild and domestic, were surveyed from the air in the national parks, safari areas, forest land and adjacent communal lands of north-west Matabeleland of western Zimbabwe during October 2014. Fixed-wing aircraft were used to conduct a sample survey, flying transects over the area. The area surveyed totalled 24959 km² and included Hwange, Zambezi and Kazuma Pan National Parks, Matetsi and Deka Safari Areas, Sikumi, Ngamo, Kazuma and Panda Masuie Forest Areas and the communal lands of Tsholotsho and Maitengwe adjacent to the south-east of Hwange NP. The area was divided into 23 strata. By design, the sampling intensity varied between strata, from 2.9 % to 13.9 %, with greater intensity in strata expected (on the basis of previous survey results) to contain greater densities of elephants. The overall sampling intensity was 7.1 %. The principal objective of the survey was to provide a relatively precise estimate of the number of elephants in the region. Secondary objectives included determining the spatial distribution of elephants, estimating the number and distribution of elephant carcasses, and estimating the numbers and distribution of other large herbivores. The methods were both repeatable and technically robust, and were similar to those used during the 2001 survey of elephants in this same region.

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

The estimated population numbers of the principal large herbivores were: elephant 53991 (upper and lower 95% confidence limits \pm 14.3 %); buffalo 5146 (\pm 108 %); zebra 4154 (\pm 59.4 %); waterbuck 1728 (\pm 127 %); sable 2586 (\pm 94.2 %); impala 4533 (\pm 47.8 %); giraffe 1568 (\pm 43.2 %); kudu 1182 (\pm 49.2 %); eland 1115 (\pm 85.1 %); cattle 10494 (\pm 59.8 %); sheep and goats 6226 (\pm 70.8 %); and donkeys 1219 (\pm 64.6 %).

There were estimated to be 45846 elephants (\pm 13.8 %) in Hwange NP, at a mean crude density of 3.0 elephants per square kilometre.

The estimated total number of all elephant carcasses (4132) represented 7.1 % of the estimated total number of live and dead elephants. This carcass ‘ratio’ compared with an estimate of 3.2 % during a similar survey in the same region during 2001. The 1+2 carcass ratio (i.e. the ratio based on only fresh or recent carcasses) was 0.35 %, which compared with 0.21 % during 2001.

There have been significant declines since 2001 in the population estimates for elephant bulls (-27 %), kudu (-57 %), giraffe (-54 %) and cattle (-49 %). Apparent declines in the estimates for buffalo, sable and warthog were not statistically significant, but were almost so ($P = 0.057$). The number of elephant carcasses had more than doubled, compared with 2001.

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Introduction

Elephant and other large herbivores, both wild and domestic, were censused in north-west Matabeleland in western Zimbabwe (Map 1). The survey was part of a national survey of the African elephant in Zimbabwe, the first since 2001 (Dunham & Mackie 2002), and was part of a continuing study to monitor the numbers of elephants and other wildlife in the Parks & Wild Life Estate of Zimbabwe. Wildlife in north-west Matabeleland was also surveyed during 2007 (Dunham *et al.* 2007), but interpretation of the results of that survey is compounded by the fact that the survey occurred relatively late during the year and rain fell during the survey. A survey in 2006 could not be completed for logistical reasons (Dunham *et al.* 2006) and the results of that partial survey are not considered here.

North-west Matabeleland includes the largest block of Parks & Wildlife Estate in Zimbabwe, which has Hwange National Park as its centrepiece. The elephant population in this region is contiguous with the elephant population in northern Botswana. There is also some movement by elephants across the Zambezi River into Zambia.

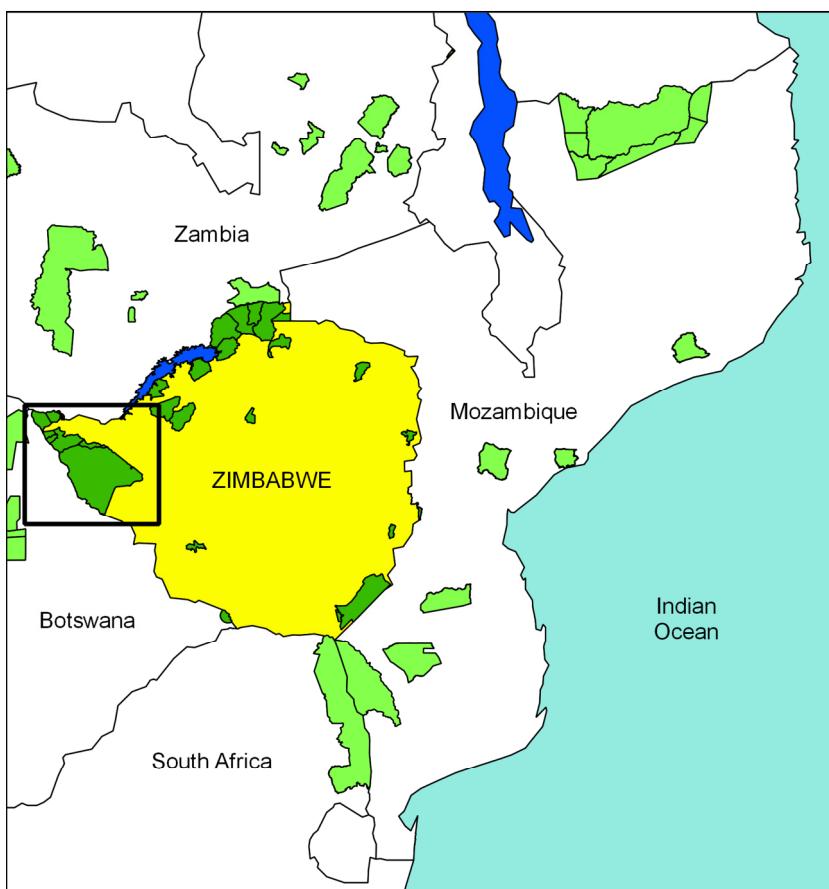
The methods used during this survey were similar to those used during the 2001 survey of the wildlife populations of north-west Matabeleland. The principal objective of the survey was to provide relatively precise and accurate estimates of the number of elephants and other large herbivores in the survey area as a whole, using a technique that could be executed within a reasonable time and at a reasonable cost. The use of methods that gave results entirely comparable with the 2001 survey was a top priority. Secondary objectives included determination of the spatial distributions of elephants and other large herbivores; and estimation of the number and spatial distribution of elephant carcasses. The methods used were suitable for meeting the survey objectives, and are repeatable and technically robust.

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Survey Area

The survey area, located in western Zimbabwe, covered 24959 km² and was divided into 23 strata (Map 4 and Table 5). The overall survey area was the same as that covered during previous surveys of this region (Dunham 2002, Gibson 1999).

The survey area included Hwange, Zambezi and Kazuma Pan National Parks, Matetsi and Deka Safari Areas, Sikumi, Ngamo, Kazuma and Panda Masuie Forest Areas and the communal lands of Tsholotsho and Maitengwe adjacent to the south-east of Hwange NP. The survey area lies within the Kavango Zambezi Transfrontier Conservation Area (KAZA).



Map 1. The location of the north-west Matabeleland survey area in western Zimbabwe

National Parks and Safari Areas in Zimbabwe are shown in dark green and selected protected areas in neighbouring countries are shown in light green. The box highlights the survey area, which is shown in more detail in the following maps.

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Methods

Survey Design

The procedures used followed those well established for aerial surveys of African large herbivores (Norton-Griffiths 1978) and utilised during earlier surveys of large herbivores in Zimbabwe. Survey procedures followed the revised standards set by the CITES MIKE programme (Craig 2012). This ensured that the data collected during the survey would be comparable with that from earlier surveys, particularly the 2001 survey. Changes to the survey design, or methods, during 2014 could have created problems, or prompted criticisms, or both, that could have compromised the analysis of the temporal variations in animal numbers.

The survey area was divided into 23 strata. The boundaries of the strata in north-west Matabeleland follow those used during the 2001 survey, but the geographic co-ordinates defining these boundaries were sometimes not a good fit to the features (e.g. roads, rivers) that defined the boundaries. (An error of say 100 m, while acceptable when digitising from a 1:250 000 scale paper map nearly 20 years ago, is less acceptable in today's world of ubiquitous GPS receivers.) Hence, a GIS file of the strata boundaries was prepared using on-screen digitising of these same features displayed on images in Google Earth. Consequently, there have been small changes to the calculated areas of the strata and the survey area, which now has a calculated area of 24959 km², compared with 25072 km² during 2001 for the same piece of land.

Systematic, parallel transects were positioned across each stratum, with the position of the first transect in a stratum determined randomly. Transects were arranged at right angles to the principal environmental feature within a stratum (see Map 5 and Table 5 for transect orientations). In order to maximise the precision of the estimate of the total number of elephants in the survey area as a whole, the sampling intensity varied between strata. Hence, the distance between adjacent transects varied between strata, according to the planned sampling intensity in each stratum. Overall sampling intensity was planned to be 7 %, with a transect width (i.e. combined width of the two search strips) of 300 m. The planned sampling intensity in each stratum was determined by using the mean of the elephant densities in each stratum during 2001 and 2007 (Dunham 2002, Dunham et al. 2007) as the predicted elephant densities in equation 1 of Gibson (1989). As a consequence, those strata expected to contain high densities of elephants were sampled more intensively than strata expected to contain few elephants. In practice, the transect spacing varied from 2.2 km in strata expected to contain numerous elephants, to 10 km in strata expected to contain few or no elephants (Table 5).

The survey was designed using the WWF-SARPO's custom software (AIRDESW, version dated 29/05/97). Given a stratum boundary in the form of an ATLAS GIS bna format file, and the transect orientation and spacing, this software generates flight lines (the transects), with the first flight line offset from the end of the stratum by an entered random number. The start and end points for each transect (Appendix 3) were transferred as waypoints to a Global Positioning System (GPS) receiver in the plane prior to flying each stratum.

Flight Procedures

All strata were surveyed during the period 7 to 23 October 2014 (Table 4).

The aircraft used for the survey was a Cessna 206. A laser rangefinder (with specifications similar to the AgLaser laser height measuring device) was mounted with a custom bracket, pointing downwards, on the right wing strut, just below the wing. The height above ground level (in feet) was displayed at 1 second intervals on a digital display mounted in the cockpit and sometimes also on a tablet computer (which used custom software that smoothed the reported temporal fluctuations in height).

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The aircraft was equipped with a Garmin Aera 500 GPS receiver. During the survey, the aircraft was flown at approximately 170 km per hour at about 300 feet above ground level. Waypoints denoting the start and end points of transects were entered into the GPS receiver and used to form routes. Navigation along the transects was undertaken by the pilot, with reference to the HIS display of the GPS receiver, with the course deviation scale set to 0.25 nautical miles. The track of the aircraft was recorded using the track log facility of Garmin GPSMAP 64 GPS receiver, set to note the aircraft's location at 1 second intervals.

The aircraft crew included a pilot (Charles Mackie), a recorder (Kevin Dunham) who sat next to the pilot, and two observers who sat behind the pilot and recorder. All four crew members could talk to one another through an intercom system. The two observers were Colum Zhuwau and Greg Nyaguse. Both had experience as survey observers, most recently during the Sebungwe survey of September 2014. The observers had been tested to ensure that they were not colour-blind (using the Ishihara test for colour blindness) and to check their visual acuity (using a Snellen eye chart, specifically their ability to read capital letters printed 7 mm high from a distance of 4.5 m).

All animals seen by the observers within the search strips (see section *Strip Width and Calibration* below) were called to the recorder, who wrote down the species, the number of individuals of the group that were within the strip, and the GPS location against the time (to the nearest 30 seconds) after the start of the transect. Locations were recorded as waypoints by the recorder using a Garmin III GPS receiver. During the survey, the actual height of the plane above ground level (agl) was recorded by the recorder, from the laser rangefinder, every 30 seconds (of time) while flying along the transects. Later the mean height above ground level for each transect was calculated. The recorder used a stopwatch to record the time (to the nearest second) taken to fly each transect. The GPS tracklog provided an additional record of times.

The Garmin III GPS receiver (also loaded with routes defining the transects) displayed a moving map, as well as the ground speed of the aircraft, the cross-track error (the distance between the intended route and the actual flight path), and the distance and time to the next transect waypoint. Thus, throughout the flight, the recorder could monitor adherence to the intended route, ground speed, and height about ground level.

Strip Width and Calibration

Two fishing rods were attached with custom brackets to each wing strut of the aircraft, so that the rods pointed backwards and parallel to the ground during level flight. The distance between the rods on each strut was arranged so that, when the aircraft was flying at 300 feet agl, this distance represented a strip about 150 m wide on the ground. Each outer rod was marked with a small piece of tape to provide the observers with a "decision point" (it was at this point that the observer decided whether an animal was inside his search strip). When deciding if animals were inside or outside the strip, the observer moved his eye so as to align the tape on the outer rod with a small piece of tape on his window, thereby ensuring that all his decisions were made at the same viewing angle.

Prior to and during the survey, the strip widths were calibrated by flying the aircraft at right angles across an airstrip that had two sets of large-sized numbers (from 0 to 35) arranged at 10-meter intervals along the side of the airstrip. The numbers were arranged as 35 34 33....2 1 0 1 2....33 34 35, with 0 near the centre of the airstrip. Each observer noted the largest and smallest number within his strip and the recorder noted the aircraft's height above ground level, as recorded by the laser rangefinder. For each flight passing over the calibration numbers, the combined strip width (in meters) was adjusted to 300 feet above ground level as follows:

$$\text{Combined strip width at 300 feet} = \frac{\text{Actual combined strip width} \times 300}{\text{Actual flying height}}$$

The combined strip widths, after adjustment to 300 feet above ground level, were then averaged to give the nominal (calibrated) combined strip width at 300 feet. This was 299 m (Appendix 1).

Readings from the laser rangefinder were compared with those from the plane's barometric altimeters (Appendix 7).

Observations

As during previous surveys of this region, the observers were instructed to search for elephants but to count also other wild large herbivores and domestic livestock (cattle, goats, sheep and donkeys). Sheep and goats are not readily distinguished during aerial surveys and so both were recorded as 'shoats'. If any animal group was too large for all the individuals within it to be counted, group size was estimated by the observer. Shortly before this survey, the observers were tested on their ability to estimate group size (see Appendix 7 of the 2014 Sebungwe survey report).

Groups of elephant bulls were differentiated from elephant cow herds (i.e. herds containing calves), although the latter may have included some bulls. The observers were instructed to note any carcasses seen. All elephant carcasses noted were classified using four age categories as follows:

Carcass category	Definition
1	Fresh Carcass still had flesh, giving the body a rounded appearance. Vultures were probably present and the ground was still moist from body fluids.
2	Recent Rot patch and skin still present. Skeleton not scattered.
3	Old Clean bones; skin usually absent; vegetation regrown in rot patch.
4	Very Old Bones scattered and turning grey.

These carcass categories differ from those used the 2001 survey of this region, when only three categories were used (Dunham 2002). The new categories are those used by Douglas-Hamilton & Hillman (1981) and now recommended by MIKE for elephant surveys (Craig 2012). MIKE (Monitoring the Illegal Killing of Elephants) is a CITES programme that uses aerial and ground surveys of elephant populations, and data collected by law-enforcement patrols, to monitor the illegal killing of elephants at representative sites across Africa and Asia. For most practical purposes, the new categories 1 and 2 are the same as the former categories 1 and 2 respectively. The new categories 3 and 4 include all carcasses that previously were placed in the former category 3.

Carcasses that could not be identified as elephant carcasses were recorded as 'unidentified carcasses'. Poachers' camps were also counted – they were identified by the presence of a fire used to dry meat or fish, and drying racks.

Data Analysis

Population estimates and 95 % confidence limits for individual strata were calculated using Jolly's (1969) method 2 for unequal-sized sample units. Given the mean combined strip width

when the plane was flying at 300 feet (i.e. the calibrated strip width), and the mean flying height for each transect, the actual combined strip width for each transect was determined. The actual combined strip width was the product of the nominal strip width at 300 ft and the mean height for the transect, divided by 300. The area of each transect was calculated as the product of the actual combined strip width and the transect length. Transect lengths were provided by the survey design software (Appendix 3).

Transects near a stratum boundary were sometimes broken into two or more sections. This was often the case when a winding river formed the stratum boundary. Land between the transect sections was in the neighbouring stratum. For analysis, data for all sections of a transect were combined (instead of treating each section as a separate transect, as the design software does). Calculation of the variance of a population estimate required the calculation of N, an integer that is the total number of transects that could have been used in the survey of a stratum. The value of N for a stratum was found by dividing the baseline length by the overall mean actual strip width for that stratum.

Thus, for each stratum, N was calculated as:

$$N = \frac{\text{Baseline length} \times 1000 \times 300}{\text{Nominal strip width} \times \text{Average flying height}}$$

where:

Baseline length = length (in km) of a straight line aligned at right angles to the orientation of the transects, and running from one end of the stratum to the far end;

Nominal strip width = calibrated combined strip width (in m) when flying at 300 feet agl; and

Average flying height = Mean of the mean flying heights (in feet) for all transects in the stratum.

The calculated value of N was rounded to the nearest integer. The value of Student's *t* used to calculate the 95 % confidence limits of a population estimate was t_{n-1} for $P = 0.05$ (Rohlf & Sokal 1981), where n = number of surveyed transects in stratum. The 95 % confidence interval is the difference between the mean population estimate and the upper (or lower) 95 % confidence limit. The lower 95 % confidence limit is zero if the calculated value is negative.

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Entire survey area and land units within it

Population estimates for the entire survey area and for various land units within it were calculated as the sum of the estimates for the individual strata within the survey area or land unit. The upper and lower 95% confidence limits for population estimates for the entire survey area or land unit were calculated as:

$$\text{Population estimate} \pm [t_v \times \text{Square root of (Sum of Variances for individual strata)}]$$

where:

v = the degrees of freedom estimated by Satterthwaite's rule (Snedecor & Cochran 1980, Gasaway et al. 1986).

v was an integer, calculated using the formula:

$$v = \frac{(\text{Sum of Variances for individual strata})^2}{\text{Sum of } [(Variance for individual stratum)^2 / (n-1)]}$$

with the outcome of this formula rounded down to the nearest integer. t_v was calculated using the EXCEL function TINV(0.05, v).

Elephant carcasses

The elephant all-carcass “ratio” *sensu* Douglas-Hamilton & Burrill (1991) - although it is a proportion or percentage, not a ratio - was calculated as the estimated number of all elephant carcasses (i.e. age categories 1, 2, 3 and 4 summed) as a percentage of the estimated number of all elephants (i.e. live + dead). Because this carcass ratio is based on all elephant carcasses, regardless of age category, the elephant all-carcass ratios and densities given here are directly comparable with the ratios and densities from the 2001 survey of this region.

Carcasses recorded by the observers as ‘unidentified’ were invariably the carcasses of large mammals. A few, if they were in the vicinity of permanent water bodies (e.g. near the Zambezi River) may have been hippopotamus carcasses, but most were likely elephant carcasses. Hence, the elephant all-carcass ratio was calculated a second time by assuming that all unidentified carcasses were elephant carcasses. Both all-carcass ratios are included in this report.

When interpreting the results of this survey, it is reasonable to assume that category 1 or 2 carcasses represent elephants that died during 2014. However, this is not the same as saying that the carcasses of all elephants that died during 2014 were still in age category 1 or 2 during the survey. This is likely not the case - some elephants that died during 2014 were probably reduced to skeletons or scattered bones by the time of the survey. Studies of the elephant population in northern Mozambique suggest that c.70% of the elephants that died there during a survey year were reduced by the time of the late-dry-season survey to just skeletons, or scattered bones; i.e. carcasses that were in age category 3 or 4 (Booth & Dunham 2015).

The 1+2 carcass ratio provides an index of elephant mortality (both natural and anthropogenic) during the survey year. It was calculated as the estimated number of elephant carcasses in age category 1 or 2 as a percentage of the sum of the estimated number of live elephants and the estimated number of carcasses in category 1 or 2.

Search Effort

The greater the time spent searching each square kilometre of a transect, the greater the probability that the observer saw all the animals that were there. Search effort (in minutes per square kilometre) for a stratum was defined as the total time spent flying all transects or blocks within that stratum, divided by the total area of those same transects or blocks. For transect surveys, the search effort is influenced by the speed of the aircraft and its height above ground level. The average ground speed of the aircraft for each transect was calculated as the transect length divided by the time taken to fly that transect. The weighted mean ground speed was calculated for each stratum as the total length of the transects in that stratum divided by the total time to fly those transects. The recordings of the aircraft height from the laser rangefinder were used to determine the mean flying height and the distribution of flying heights for the survey as a whole.

Even the largest herbivores are not easily seen from the air and the numbers of all species were probably underestimated, with the degree of underestimation greater for small or cryptic species than for large species. However, population estimates are given for all species, because the estimates provide useful indices of abundance (with measures of precision) that can be used to determine spatial distribution, as well as temporal trends in population number (Dunham 2012). No corrections have been applied to any of the estimates to compensate for any undercounting or missed animals.

Results

Search Effort

Search effort averaged 1.14 minutes km⁻² for the entire survey area (Table 5). The mean ground speed on the transects was 173 km per hour (Table 5) and, for >90 % of transects, the mean speed was <190 km per hour. On the transects, the mean flying height was 305 feet above ground level (Appendix 6).

Animal Numbers

The estimated numbers of elephants, elephant bulls in bull groups, elephants in cow herds, elephant carcasses (age categories 1, 2, 3 and 4), unidentified carcasses, buffalo, impala, sable, zebra,, giraffe, kudu, warthog, wildebeest, waterbuck, eland, roan, gemsbok, cattle, sheep and goats, donkeys, ostrich and ground hornbill are given in Tables 6 to 31 respectively. Estimates are given for each stratum, for various land units within the survey area (the Matetsi complex, Hwange NP, Forest Areas, and communal lands) and for the entire survey area, i.e. north-west Matabeleland. In addition, a separate summary table is provided for north-west Matabeleland (Table 1).

The columns in these tables give (from left to right):

- the name of the **stratum**;
- the **estimate** of the number of animals of that species (or of carcasses, camps, etc.) in that stratum, in other words the population estimate;
- the number of individuals of that species seen (**No. seen**) *inside the search strips or blocks* during the survey of that stratum;
- the **variance** of the estimated number of animals in that stratum;
- the 95 % confidence interval of the population estimate for that species in the stratum, as a percentage of the population estimate for that stratum (% **CI**);
- the lower 95 % confidence limit of the population estimate (**Lower CL**); and
- the upper 95 % confidence limit of the population estimate (**Upper CL**).

The last row of each table gives the same measures for the entire survey area and additional rows give subtotals for various land units within the survey area. There may appear to be small arithmetical errors in some tables, but these are simply rounding errors: all numbers in the tables were calculated to three decimal places before they were rounded to the required number of decimal places. If the number of individuals seen (**No. seen**) is greater than the calculated lower confidence limit (**Lower CL**), then it is biologically meaningful to replace the calculated lower confidence limit with the number seen.

For practical purposes, it can be assumed that the number of a given species in a given land unit lies between the lower and upper confidence limits, with the 'estimate' providing the best estimate of the number there. For example, from Table 6, one can say that there were between 46280 and 61702 elephants in north-west Matabeleland, with 53991 being the best estimate of the number of elephants in the region. For practical purposes, one might say that there were between 46000 and 62000 elephants in north-west Matabeleland during the 2014 dry season, with 54000 being the best estimate of the number of elephants there.

Small numbers of baboon, bushbuck, cheetah, crocodile, grey duiker, hippopotamus, hyaena, klipspringer, lion and steenbok were seen during the survey, but no attempt has been made to estimate the numbers of these species. No tsessebe, or rhinoceros were seen during the survey.

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Table 1. Population estimates and statistics for major wildlife species, domestic livestock and elephant carcasses in north-west Matabeleland during October 2014

Species	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Elephant	53991	4926	15140043	14.3	46280	61702	2.16
Elephant bulls	6231	607	370290	19.4	5022	7439	0.25
Elephant cows	47761	4319	14769753	15.9	40143	55378	1.91
Elephant carcass 1	42	4	1111	165.2	4	112	0.002
Elephant carcass 2	149	9	2897	73.9	39	259	0.01
Elephant carcass 3	1001	80	24826	31.6	685	1318	0.04
Elephant carcass 4	2940	251	50506	15.1	2495	3385	0.12
Unidentified carcass	740	52	12992	31.0	511	970	0.03
Buffalo	5146	340	6457426	107.6	340	10683	0.21
Cattle	10494	414	8429631	59.8	4222	16766	0.42
Donkeys	1219	39	132682	64.6	432	2006	0.05
Eland	1115	71	206662	85.1	166	2063	0.04
Gemsbok	8	1	59	191.9	1	24	0.0003
Giraffe	1568	122	111650	43.2	890	2246	0.06
Ground hornbill	488	29	49484	117.1	29	1060	0.02
Impala	4533	363	1139279	47.8	2368	6697	0.18
Kudu	1182	86	80182	49.2	600	1764	0.05
Ostrich	85	7	2965	138.5	7	203	0.003
Poachers' camp	0	0	0	0.0	0	0	0.00
Roan	214	15	6820	78.5	46	382	0.01
Sable	2586	158	1196557	94.2	158	5024	0.10
Sheep / Goats	6226	237	4576414	70.8	1820	10632	0.25
Warthog	546	46	19274	53.2	256	837	0.02
Waterbuck	1728	91	472705	126.6	91	3917	0.07
Wildebeest	818	30	656721	242.3	30	2801	0.03
Zebra	4154	295	1086965	59.4	1688	6619	0.17

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Animal Distributions

The spatial distribution of the principal wild herbivores is shown in Maps 6 to 8 and 11 to 20. The distribution is shown in two ways. First, each stratum is shaded to represent the average density of the given species in that stratum. Secondly, the locations of sightings of groups of the given species are shown, together with an indication of the size of the group. The strata were sampled with systematically-arranged transects and so maps of the locations of animal sightings provide information on the spatial distribution of the animal groups. However, it must be remembered that the recorded number of groups of any species was determined by both group density and the sampling intensity – which, by design, varied between strata (Table 5).

The spatial distributions of elephant carcasses and unidentified carcasses are shown in Maps 9 and 10.

Human Activities

The spatial distributions of domestic livestock are shown in Maps 21 to 23.

No poachers' camps were seen during the survey.

Comparison of Observers

The left observer saw more elephant bull groups and cow herds than the right observer (Appendix 5). He also saw more elephant carcasses in age categories 3 and 4, as well as more groups of giraffe and ground hornbill. The left observer saw smaller groups of donkeys and larger groups of impala than the right observer.

If one assumes that the differences in elephant group number occurred solely because the left observer was more efficient at spotting elephant groups than the right one, then the population estimate for all elephants would increase by 18 % (Appendix 5). However, this approach may be too simple, because the total number of elephants (both inside and outside the search strips) seen by the two observers were remarkably similar: the left observer saw 723 elephant bulls and 4638 elephants in cow herds, while the right observer saw 700 bulls and 4648 elephants in cow herds. These numbers suggest that the observers were equally efficient at spotting elephants, but that – for whatever reason – the left observer judged a greater proportion of the groups that he saw to be inside the search strip than did the right observer.

For elephant carcasses, it does appear that the left observer was more efficient than the right observer (Appendix 5). If the left and right observers had been similarly efficient at spotting carcasses, the estimated number of carcasses 3 and 4 in north-west Matabeleland would increase by approximately 33 %.

Elephant Carcasses

The 1+2 carcass ratio represents the number of elephant carcasses in age category 1 or 2 as a percentage of the sum of the number of live elephants and the number of such carcasses. In other words, it provides an index of the *mortality rate* of elephants during the year of the survey. The 1+2 carcass ratio for north-west Matabeleland was 0.35 % during 2014 (Table 13). The estimated number of all elephant carcasses regardless of age category was 4132 (CI 562) during 2014 and the all-carcass ratio was 7.1 %. If it is assumed that all 'unidentified' carcasses were elephant carcasses (and in 2014 the majority were), then the all-carcass ratio increases to 8.3 %.

Temporal Variation in Animal Numbers in north-west Matabeleland

Aerial surveys of the wildlife in Hwange NP and the Matetsi complex were conducted most years during the 1980s and 1990s. For most years during the 1980s, these two areas were surveyed independently, but from 1989 onwards, both areas were covered during a single survey. The earliest surveys were usually of elephant and a few other species, e.g. buffalo, zebra and giraffe during the 1981 Hwange survey, and sable during the 1981 Matetsi survey. In later years the range of species surveyed was widened: by 1994, all medium-sized and large herbivores (i.e. impala upwards) were included. Also from 1994, elephants were distinguished as elephants in bull groups, or elephants in cow or breeding herds. For elephant and some other species, the temporal variation in numbers are shown separately for north-west Matabeleland, for Hwange National Park, and for the Matetsi complex. From 1990, the north-west Matabeleland survey area included not only Hwange NP and the Matetsi complex, but also Sikumi and Ngamo Forests and communal lands adjacent to Hwange NP. The population estimates from the 2007 survey are included in the figures that follow, but the reader is reminded of the caveat mentioned earlier.

The statistical significance of changes in estimated number since 2001 (the year of the last nationwide elephant survey in Zimbabwe) was determined using two-tailed *t* tests (Gasaway *et al* 1986) (Tables 2 to 4, for north-west Matabeleland, Hwange NP and Matetsi complex respectively). The analyses reveal that there have been declines since 2001 in the population estimates for elephant bulls, kudu, giraffe and cattle in north-west Matabeleland. Apparent declines in the estimates for buffalo, sable and warthog were not statistically significant, but were almost so ($P = 0.057$). The total number of elephant carcasses had increased since 2001. In Hwange NP, there were declines in the number of elephant bulls and giraffe, and an increase in the number of elephant carcasses. In the Matetsi complex, the numbers of elephant bulls, warthog and kudu had declined.

The number of elephant in Hwange NP and hence in north-west Matabeleland increased from 1993 until 2001, but since 2001 has either remained stable, or increased only slightly (with any increase being statistically insignificant). That the elephant population is no longer increasing as fast as it was is consistent with the relatively high mortality rate (as indexed by the 1+2 carcass ratio) and the increase in the number of elephant carcasses. The current phase of increasing carcass numbers dates from 1998.

Whilst most species had not changed in number since 2001, visual examination of the temporal variation in population numbers over the period that aerial sample surveys were conducted suggests that several species have declined in number, but with the decline starting before 2001. These species include buffalo, zebra, wildebeest and maybe kudu in Hwange NP, and sable and waterbuck in the Matetsi complex.

Table 2. Statistical significance of changes in the estimated numbers of large herbivores in north-west Matabeleland since the 2001 survey

The percentage change in estimated number is given only if the change is statistically significant (i.e. P < 0.05).

Species / observation	2001		2014		Difference		Change (%)
	Estimate	% CI	Estimate	% CI	t'	P	
Elephant	49310	12.3	53991	14.3	0.9438	0.346	
Elephant bulls	8538	13.0	6231	19.4	2.7888	0.006	-27
Elephant cows	40772	14.7	47761	15.9	1.4291	0.154	
Elephant carcass 1	46	149.8	42	165.2	0.0878	0.931	
Elephant carcass 2	58	98.0	149	73.9	1.5085	0.138	
Elephant carcass 3	1536	22.7	1001	31.6	2.2741	0.025	-35
Elephant carcass 4			2940	15.1	13.081		
Elephant carcass all	1640	21.9	4132	13.5	7.4631	<0.001	152
Unidentified carcass	1071	21.8	740	31.0	2.0146	0.046	-31
Buffalo	13703	52.9	5146	107.6	1.9563	0.057	
Cattle	20390	32.4	10494	59.8	2.3033	0.028	-49
Eland	725	71.0	1115	85.1	0.7481	0.460	
Giraffe	3437	23.7	1568	43.2	3.5558	0.001	-54
Impala	5207	32.4	4533	47.8	0.4965	0.621	
Kudu	2735	28.7	1182	49.2	3.2100	0.002	-57
Sable	5854	43.9	2586	94.2	1.9959	0.057	
Sheep / Goats	5247	65.3	6226	70.8	0.3737	0.711	
Warthog	1230	53.8	546	53.2	2.0210	0.057	
Waterbuck	821	71.1	1728	126.6	1.2286	0.287	
Wildebeest	599	130.7	818	242.3	0.2487	0.810	
Zebra	6566	24.5	4154	59.4	1.8500	0.083	

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Table 3. Statistical significance of changes in the estimated numbers of large herbivores in Hwange NP since the 2001 survey

The percentage change in estimated number is given only if the change is statistically significant (i.e. P < 0.05).

Species / observation	2001		2014		Difference		Change (%)
	Estimate	% CI	Estimate	% CI	t'	P	
Elephant	44492	13.1	45846	13.8	0.3122	0.755	
Elephant bulls	7311	13.8	5782	19.1	2.0353	0.043	-21
Elephant cows	37180	15.5	40063	15.5	0.6749	0.501	
Elephant carcass 1	46	149.8	42	165.2	0.0878	0.931	
Elephant carcass 2	45	113.2	63	105.7	0.4404	0.662	
Elephant carcass 3	739	29.9	797	35.2	0.3297	0.743	
Elephant carcass 4	-	-	2084	17.1	11.638		
Elephant carcass all	830	28.5	2986	15.4	8.3328	0.000	260
Unidentified carcass	647	25.6	419	33.0	2.1153	0.036	-35
Buffalo	6663	75.6	2186	97.9	1.6627	0.103	
Eland	602	82.9	639	113.5	0.0870	0.931	
Giraffe	2649	25.9	1158	54.6	3.2510	0.002	-56
Impala	3242	42.4	3186	55.2	0.0506	0.960	
Kudu	937	40.3	617	60.1	1.2384	0.220	
Sable	1182	53.5	920	90.2	0.5134	0.610	
Warthog	429	65.2	425	50.9	0.0213	0.983	
Waterbuck	218	127.6	536	78.8	1.3092	0.198	
Wildebeest	242	178.2	0	0.0	1.1707	-	
Zebra	2933	32.3	2065	50.0	1.2489	0.215	

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Table 4. Statistical significance of changes in the estimated numbers of large herbivores in the Matetsi complex since the 2001 survey

The percentage change in estimated number is given only if the change is statistically significant (i.e. P < 0.05).

Species / observation	2001		2014		Difference		Change (%)
	Estimate	% CI	Estimate	% CI	t'	P	
Elephant	4201	41.3	4843	67.6	0.3696	0.715	
Elephant bulls	873	48.2	199	96.6	3.0759	0.004	-77
Elephant cows	3328	50.8	4646	70.3	0.7646	0.453	
Elephant carcass 1	0	0	0	0.0			
Elephant carcass 2	13	237.5	59	124.8	1.3262	0.209	
Elephant carcass 3	552	41.3	133	109.6	3.4036	0.003	-76
Elephant carcass 4			630	33.7	6.0894		
Elephant carcass all	565	40.6	822	31.6	1.5662	0.126	
Unidentified carcass	219	50.0	156	78.1	0.8169	0.420	-
Buffalo	6693	83.4	1733	289.8	1.5499	0.141	
Eland	74	145.5	476	167.8	1.3804	0.240	
Giraffe	597	40.1	350	74.4	1.4724	0.150	
Impala	1965	54.6	1347	111.6	0.7851	0.446	
Kudu	1484	41.9	484	95.8	2.7441	0.010	-67
Sable	2549	68.1	712	142.7	2.1607	0.052	
Warthog	754	81.7	121	193.5	2.2018	0.050	-84
Waterbuck	603	90.5	1192	175.1	0.8445	0.446	
Wildebeest	16	260.8	0	0.0	0.9857		
Zebra	3634	37.9	2089	120.9	1.3998	0.199	

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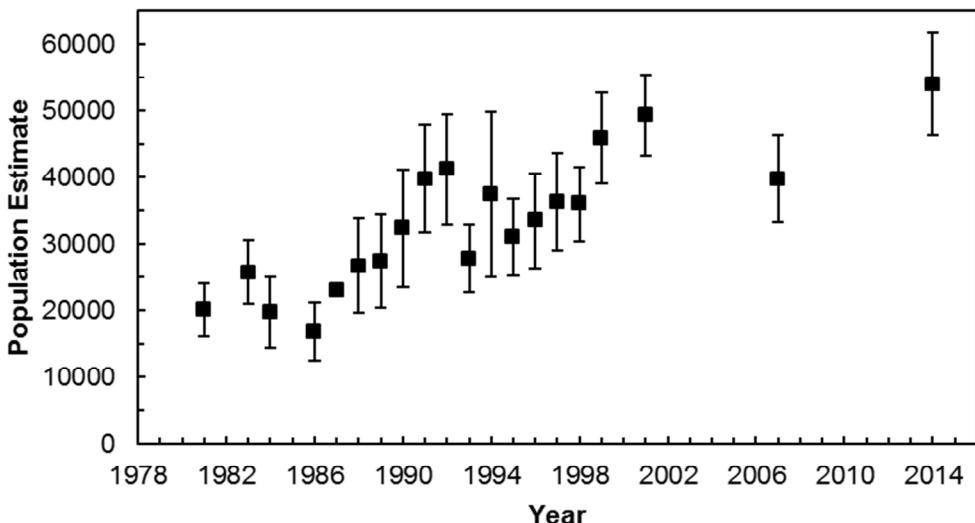


Fig. 1. Number of elephant estimated to be in north-west Matabeleland since 1981

Mean population estimates and 95% confidence intervals shown.

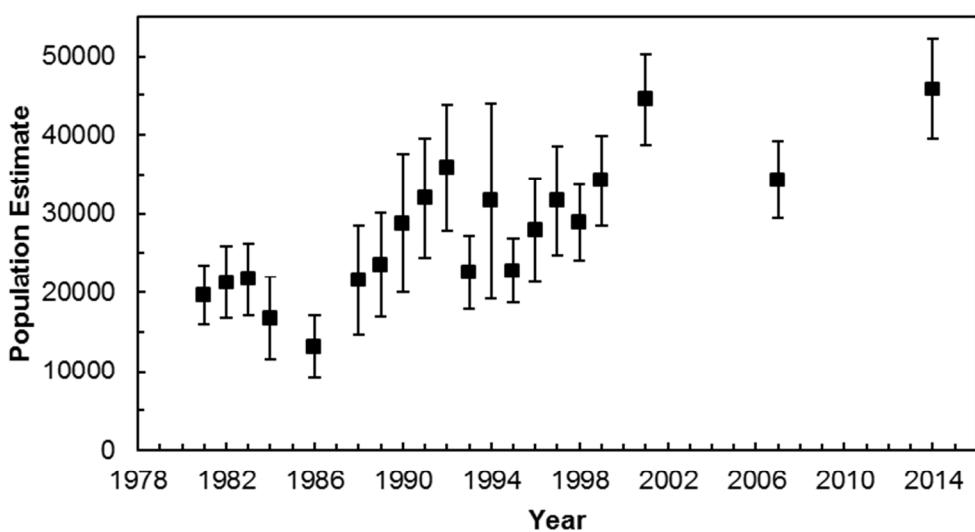


Fig. 2. Number of elephant estimated to be in Hwange NP since 1981

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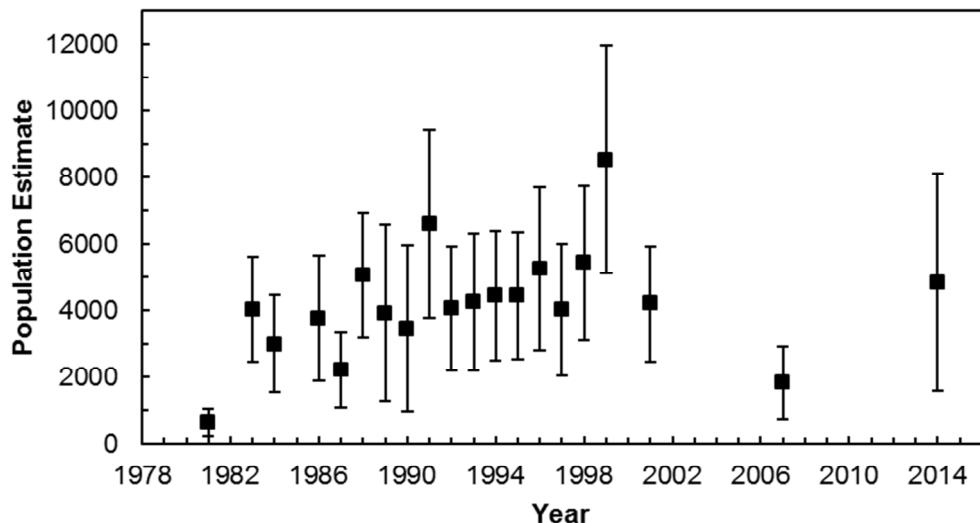


Fig. 3. Number of elephant estimated to be in the Matetsi complex since 1981

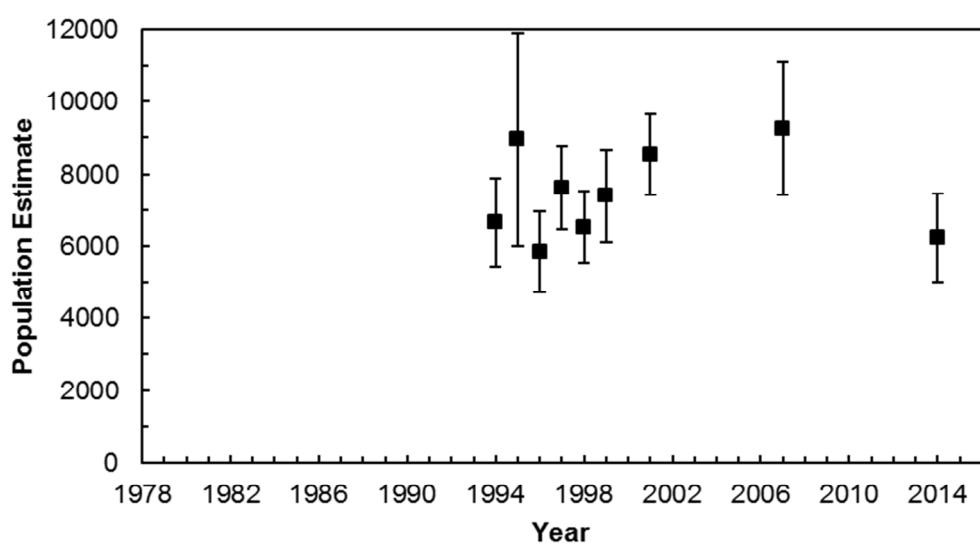


Fig. 4. Number of elephant bulls estimated to be in north-west Matabeleland since 1994

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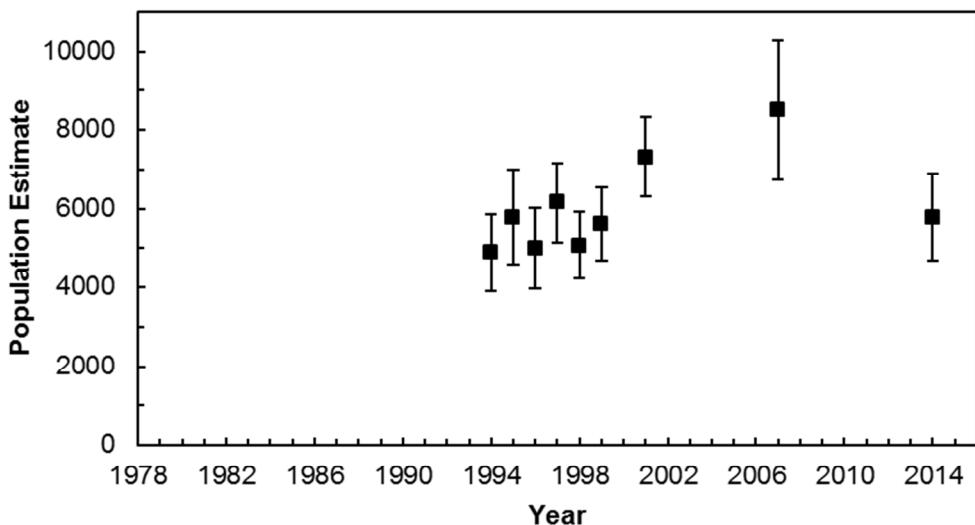


Fig. 5. Number of elephant bulls estimated to be in Hwange NP since 1994

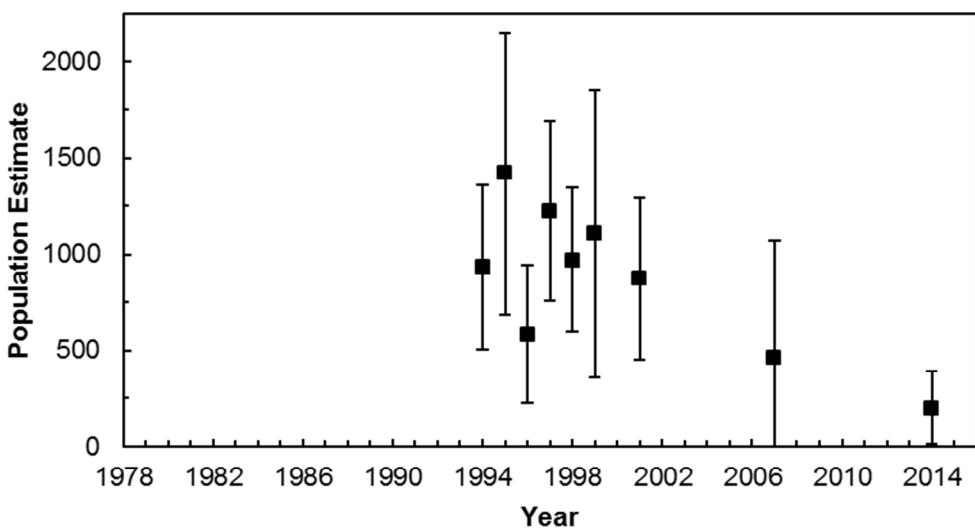


Fig. 6. Number of elephant bulls estimated to be in the Matetsi complex since 1994

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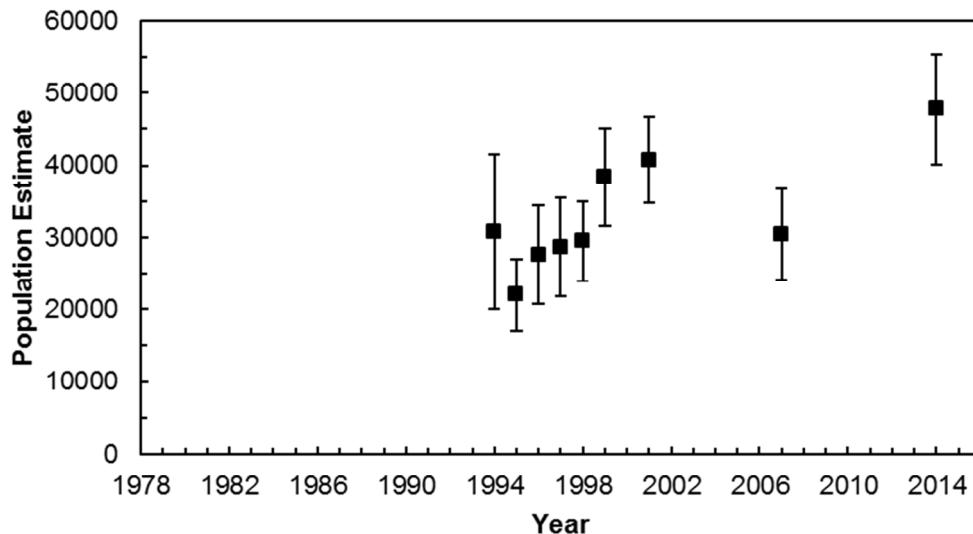


Fig. 7. Number of elephants in cow herds estimated to be in north-west Matabeleland since 1994

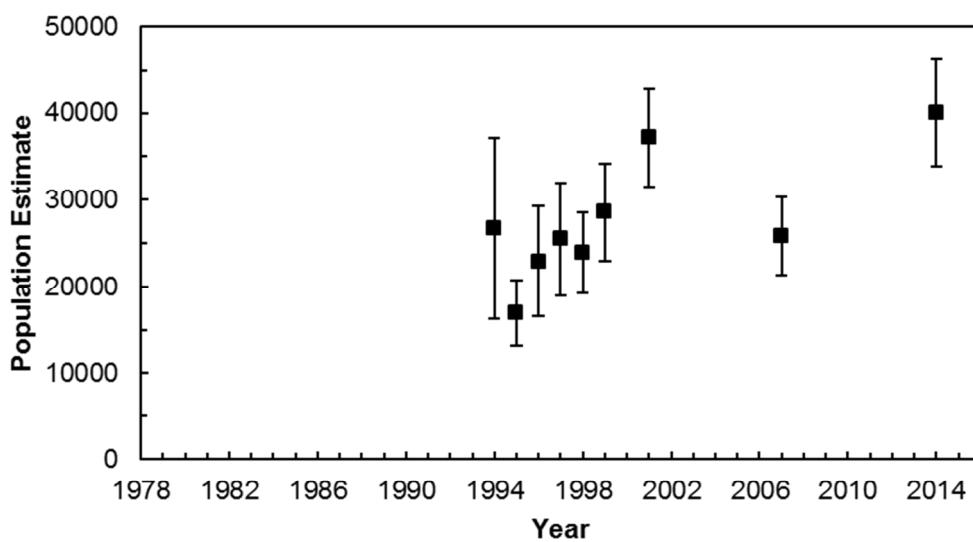


Fig. 8. Number of elephants in cow herds estimated to be in Hwange NP since 1994

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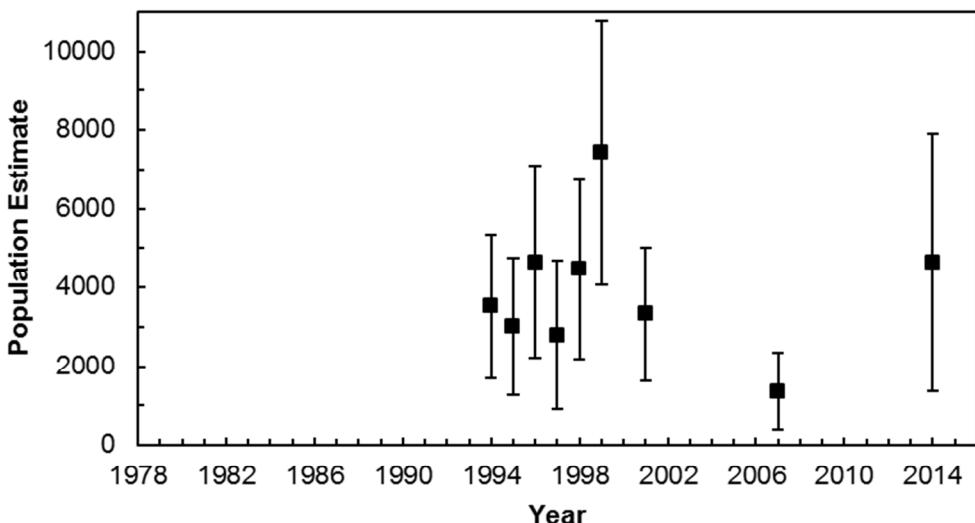


Fig. 9. Number of elephants in cow herds estimated to be in the Matetsi complex since 1994

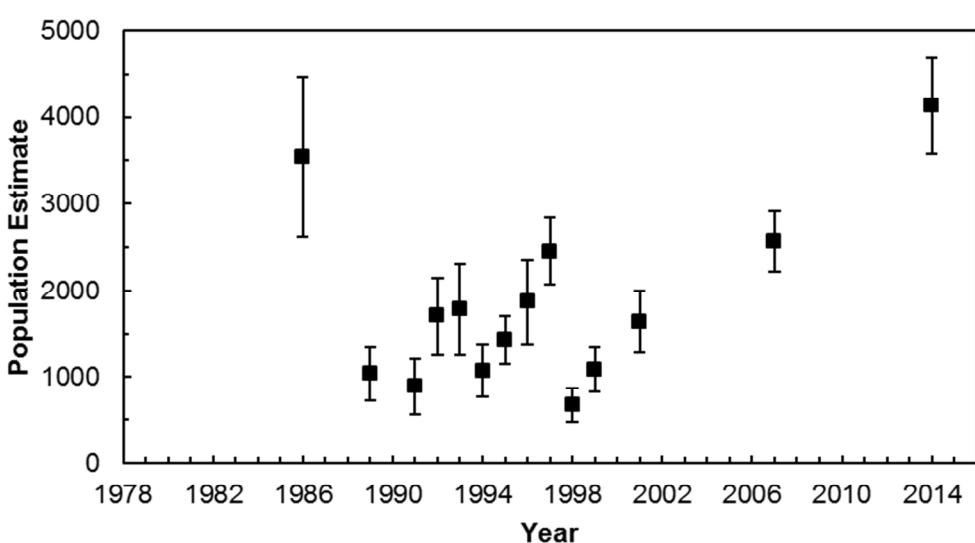


Fig. 10. Number of elephant carcasses estimated to be in north-west Matabeleland since 1986

Estimates based on elephant carcasses in all age categories.

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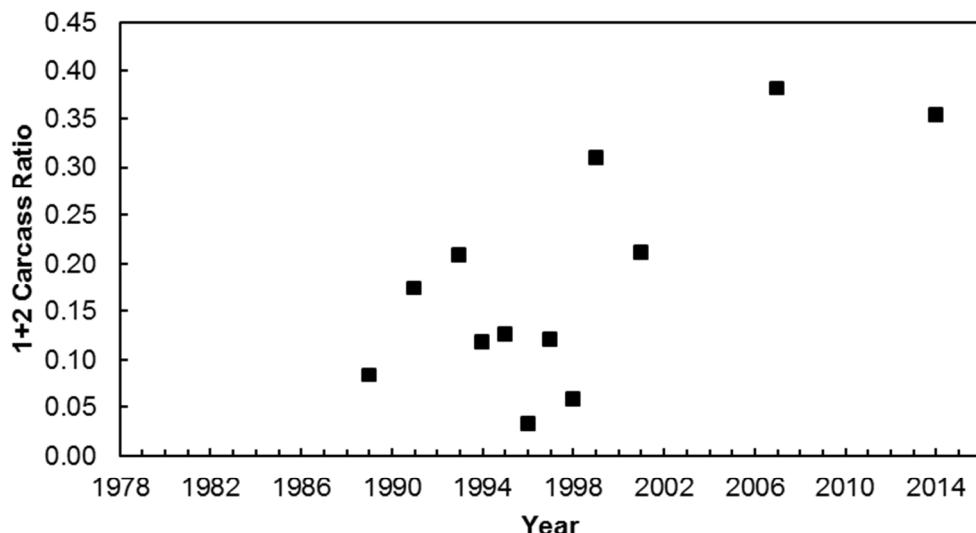


Fig. 11. The 1+2 carcass ratio for elephants in north-west Matabeleland since 1989

The 1+2 carcass ratio provides an index of the mortality rate of elephants during the year of the survey.

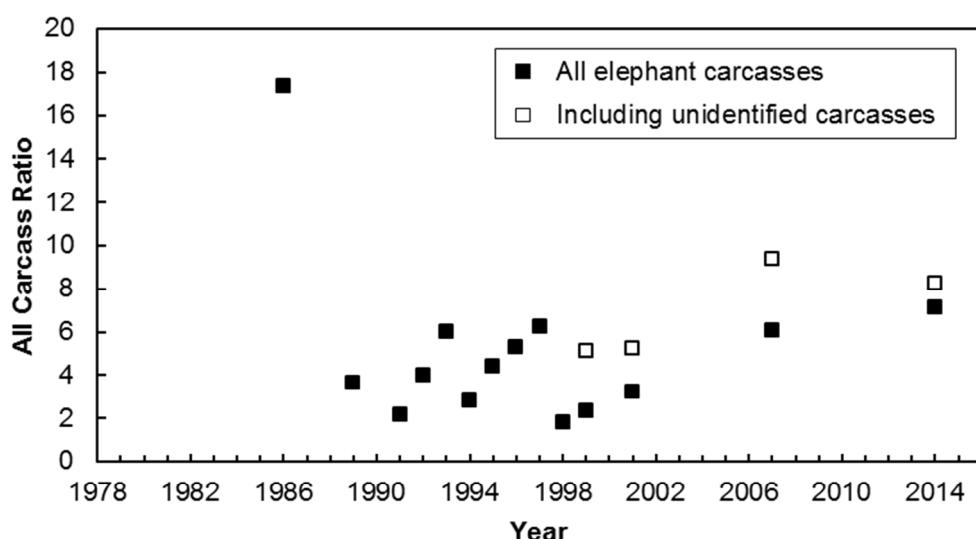


Fig. 12. The all-carcass ratio for elephants in north-west Matabeleland since 1986

The all-carcass ratio is calculated for all elephant carcasses, regardless of the age of the carcass. If it is assumed that all 'unidentified' carcasses were in fact elephant carcasses, then the all-carcass ratio would be increased as shown.

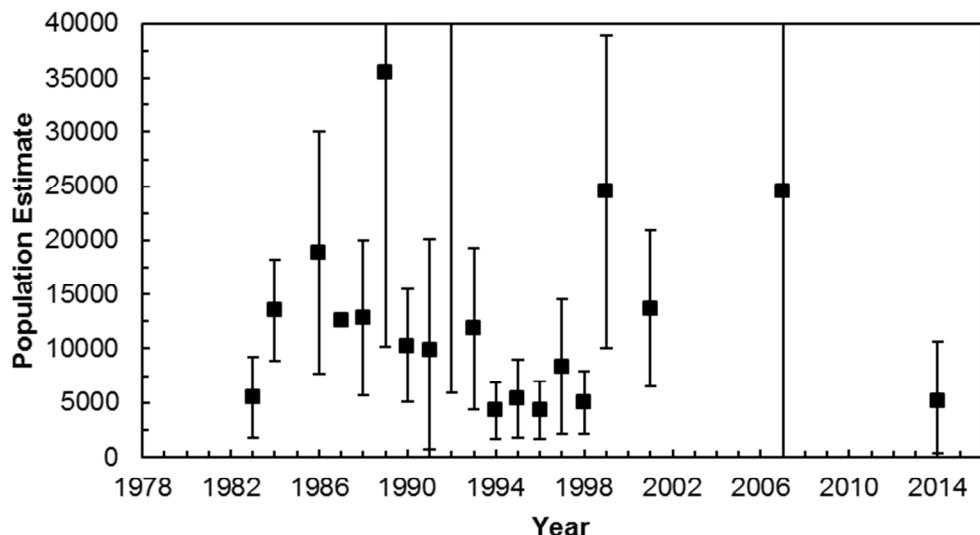


Fig. 13. Number of buffalo estimated to be in north-west Matabeleland since 1983

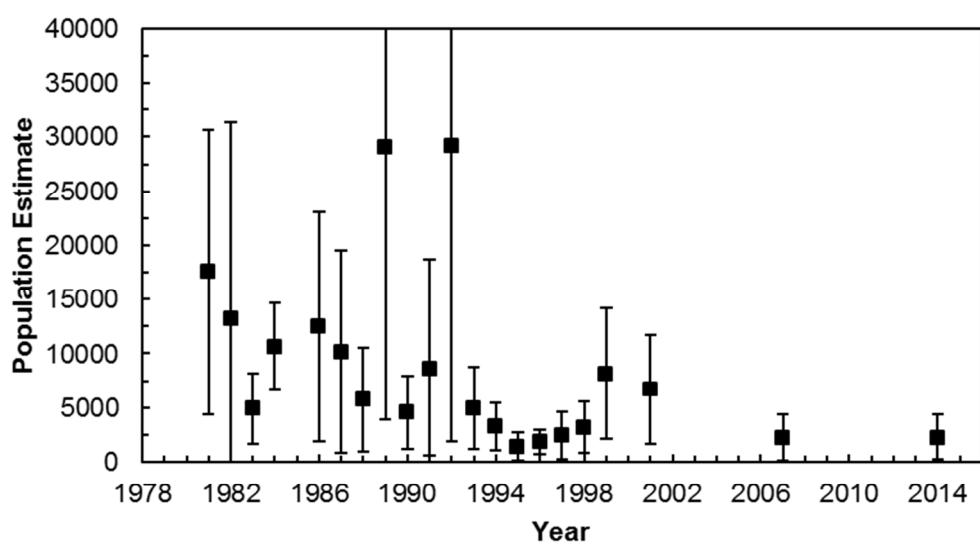


Fig. 14. Number of buffalo estimated to be in Hwange NP since 1981

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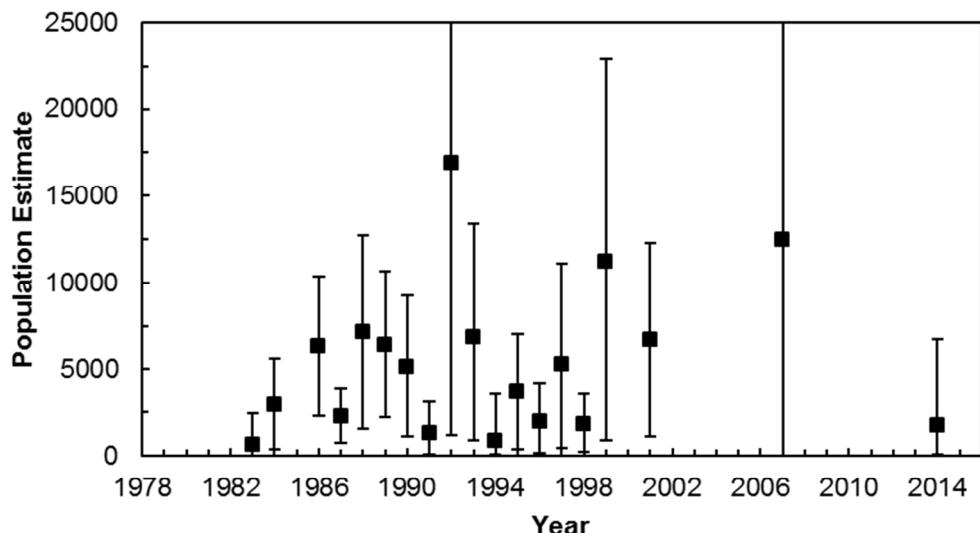


Fig. 15. Number of buffalo estimated to be in the Matetsi complex since 1983

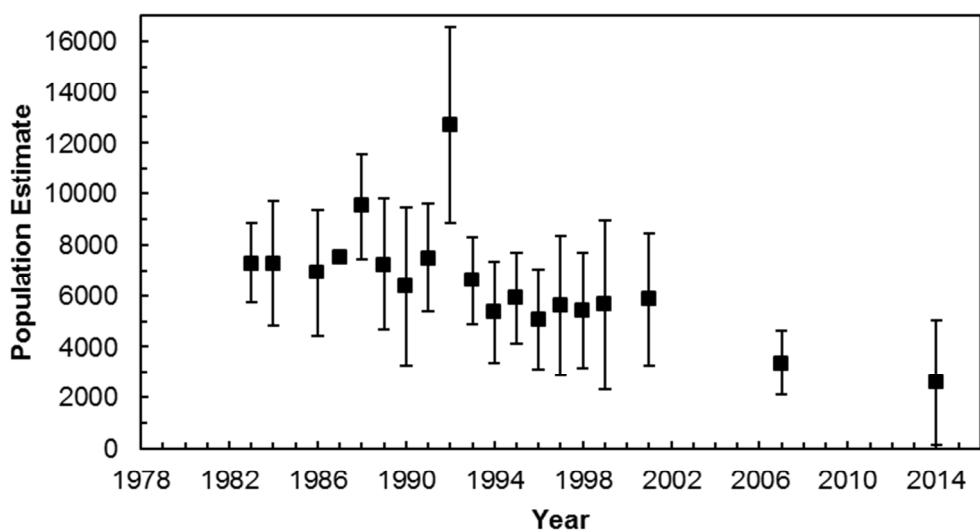


Fig. 16. Number of sable estimated to be in north-west Matabeleland since 1983

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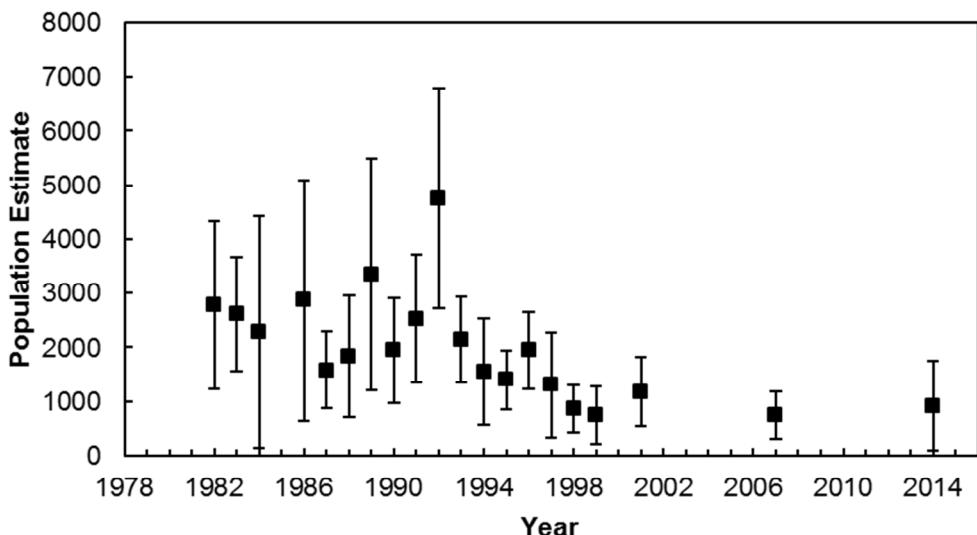


Fig. 17. Number of sable estimated to be in Hwange NP since 1982

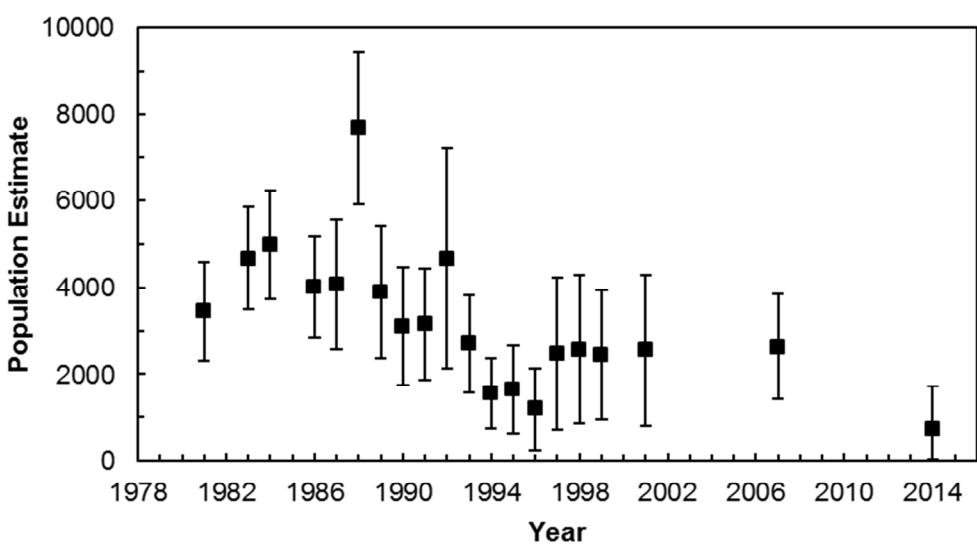


Fig. 18. Number of sable estimated to be in the Matetsi complex since 1981

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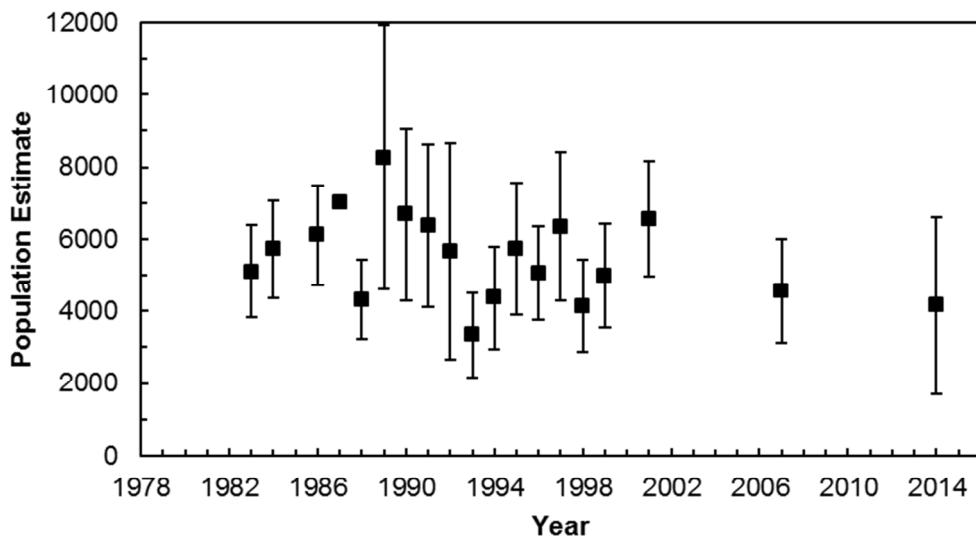


Fig. 19. Number of zebra estimated to be in north-west Matabeleland since 1983

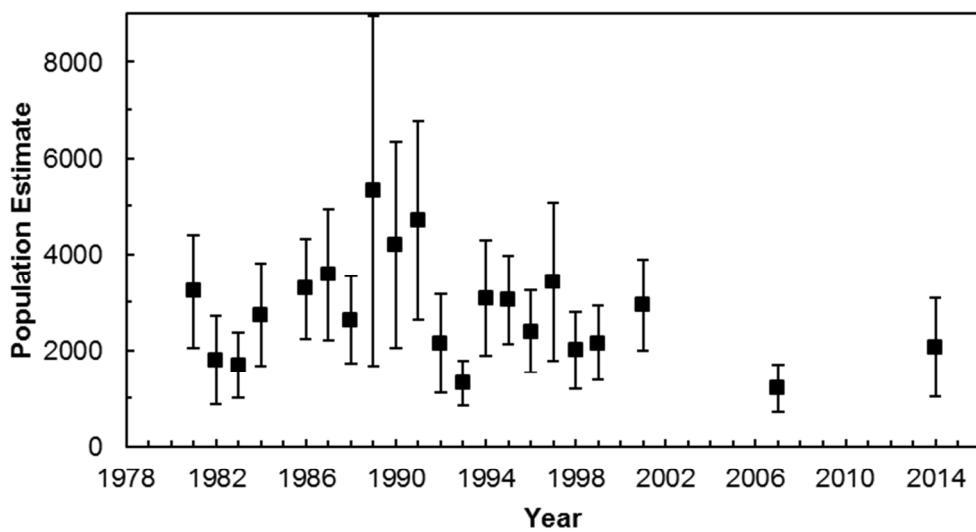


Fig. 20. Number of zebra estimated to be in Hwange NP since 1981

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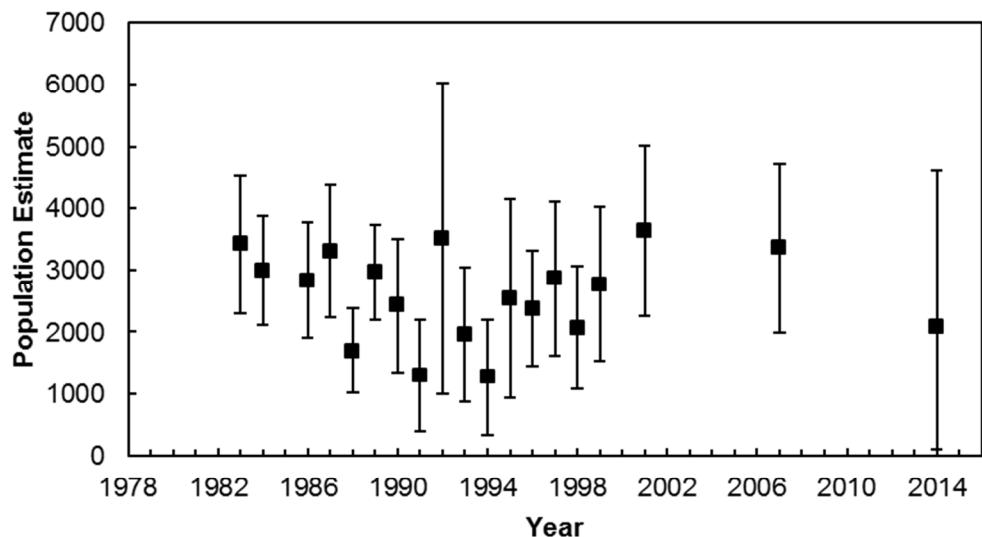


Fig. 21. Number of zebra estimated to be in the Matetsi complex since 1983

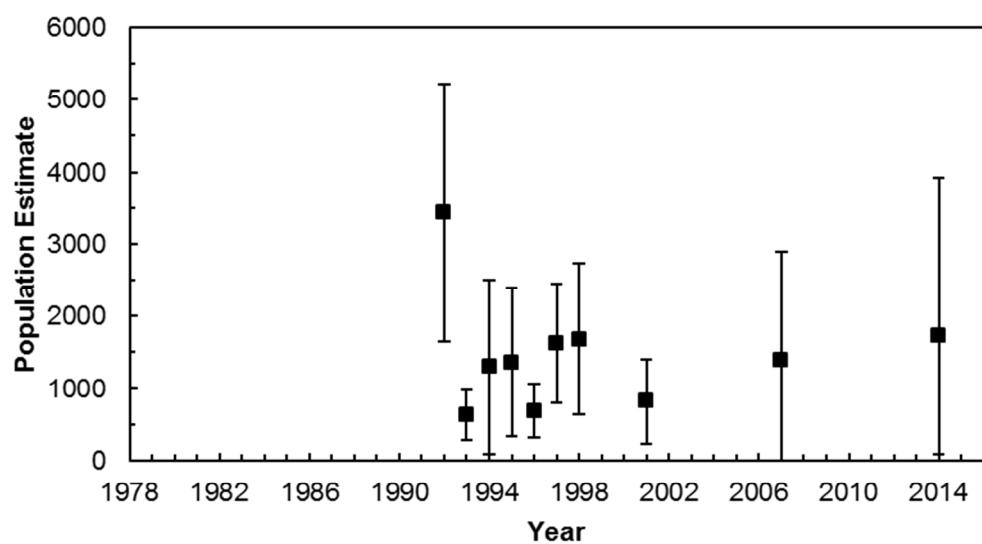


Fig. 22. Number of waterbuck estimated to be in north-west Matabeleland since 1992

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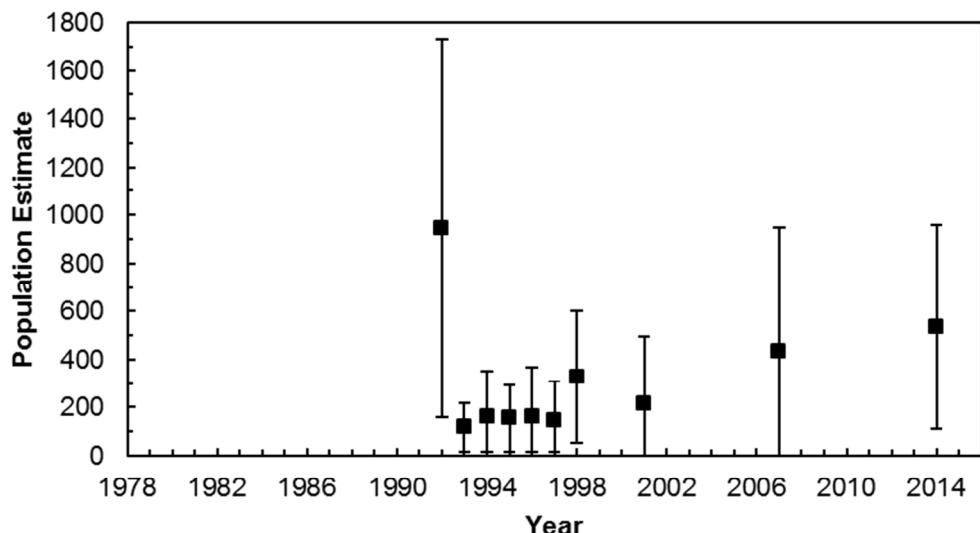


Fig. 23. Number of waterbuck estimated to be in Hwange NP since 1992

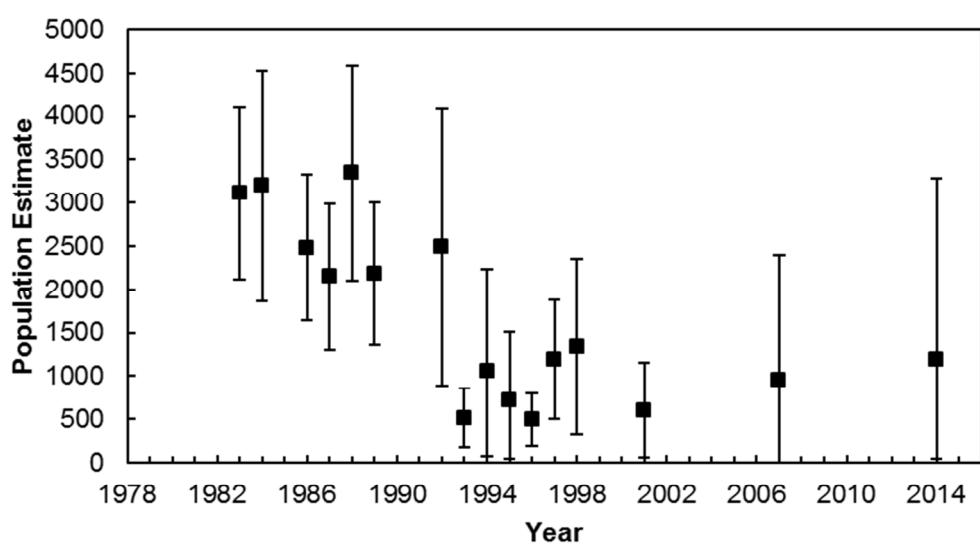


Fig. 24. Number of waterbuck estimated to be in the Matetsi complex since 1983

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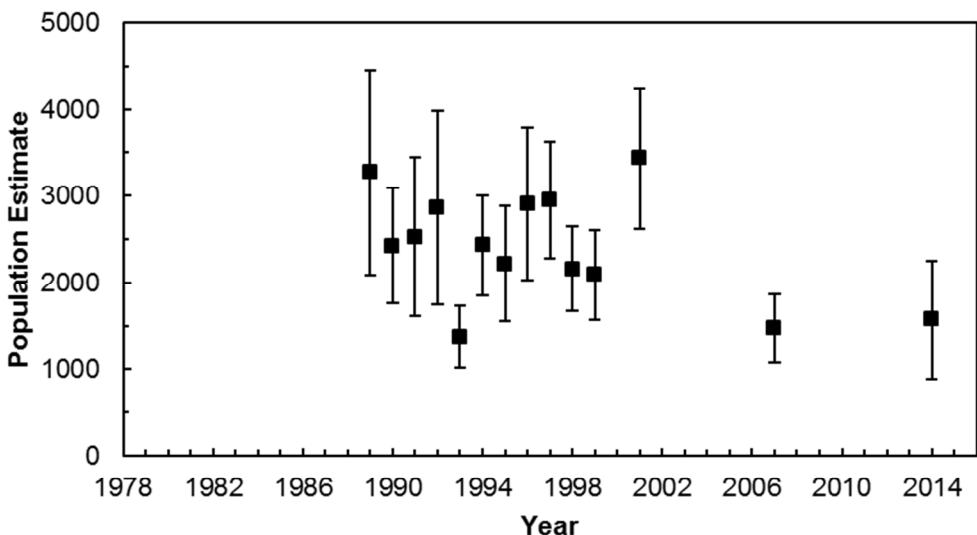


Fig. 25. Number of giraffe estimated to be in north-west Matabeleland since 1989

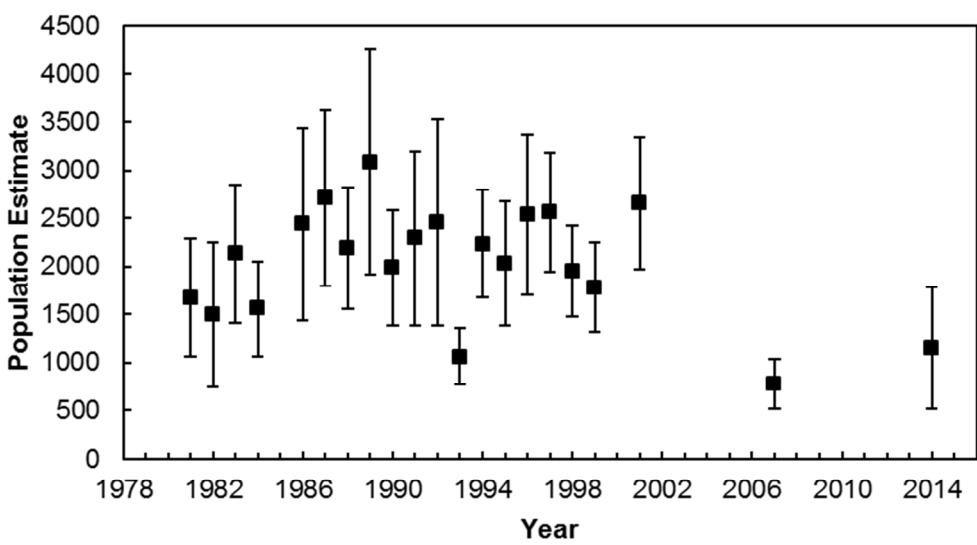


Fig. 26. Number of giraffe estimated to be in Hwange NP since 1981

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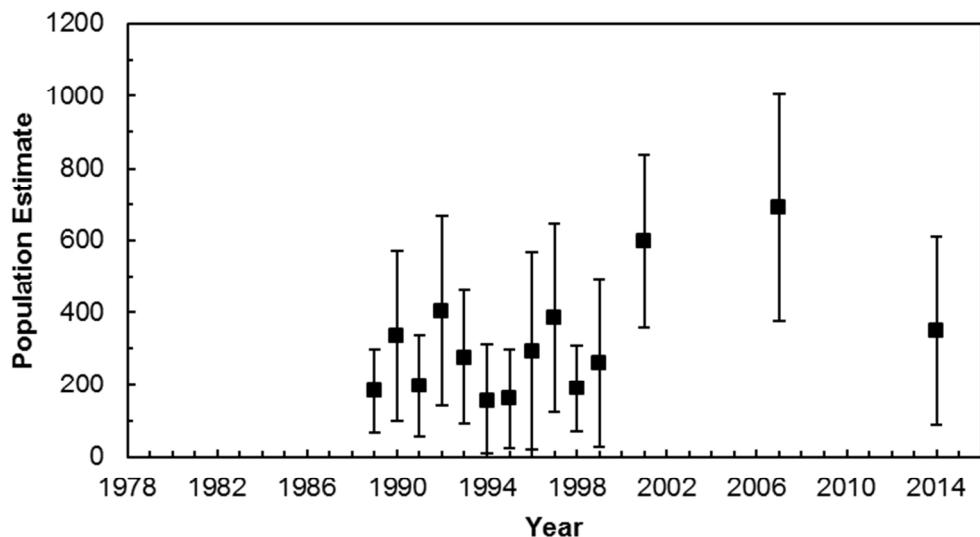


Fig. 27. Number of giraffe estimated to be in the Matetsi complex since 1989

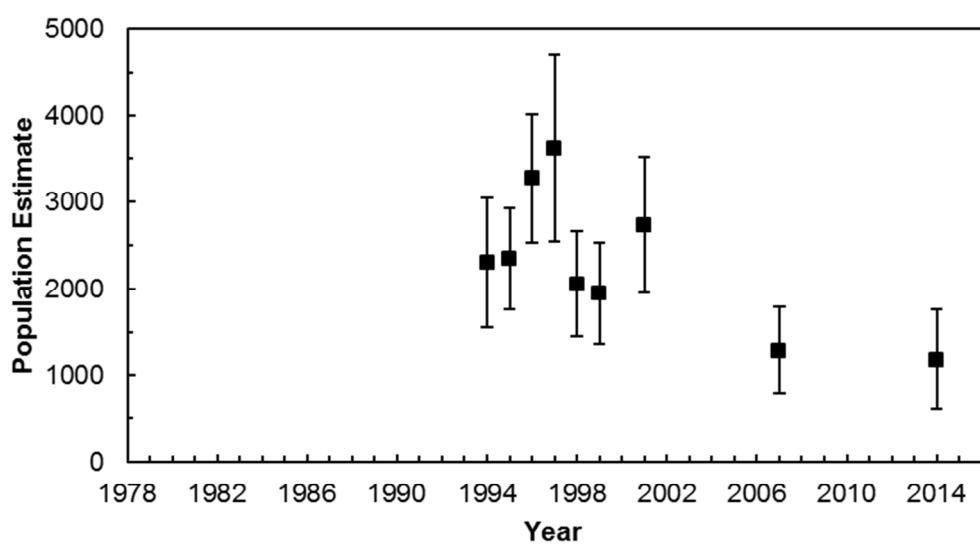


Fig. 28. Number of kudu estimated to be in north-west Matabeleland since 1994

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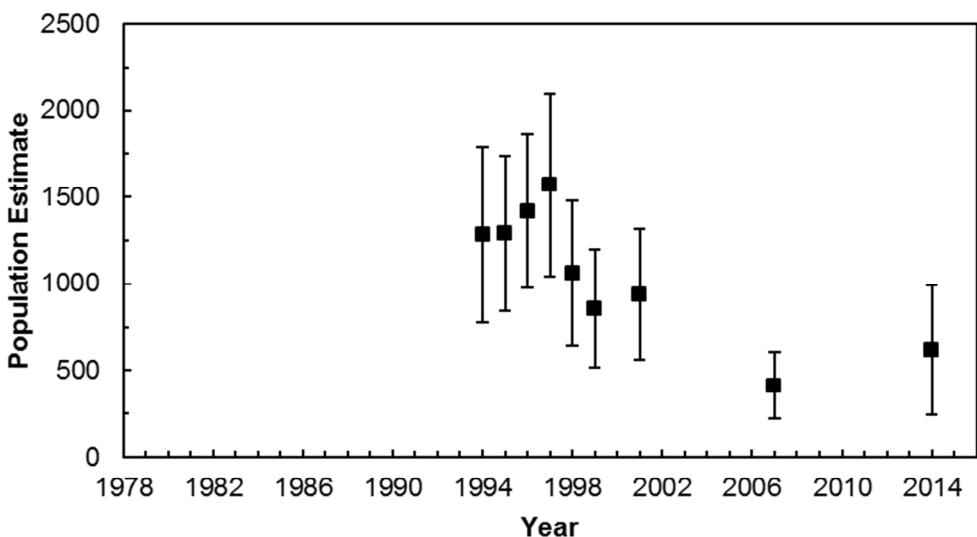


Fig. 29. Number of kudu estimated to be in Hwange NP since 1994

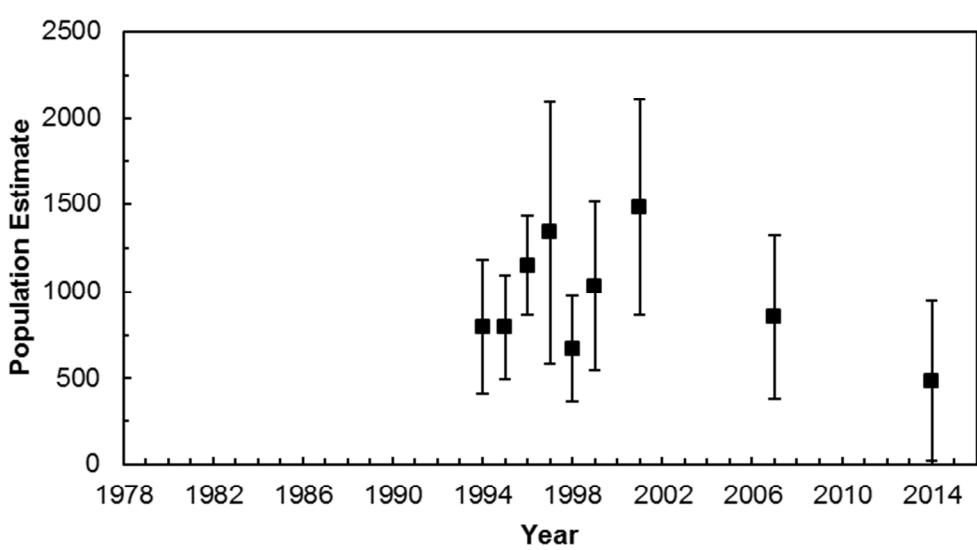


Fig. 30. Number of kudu estimated to be in the Matetsi complex since 1994

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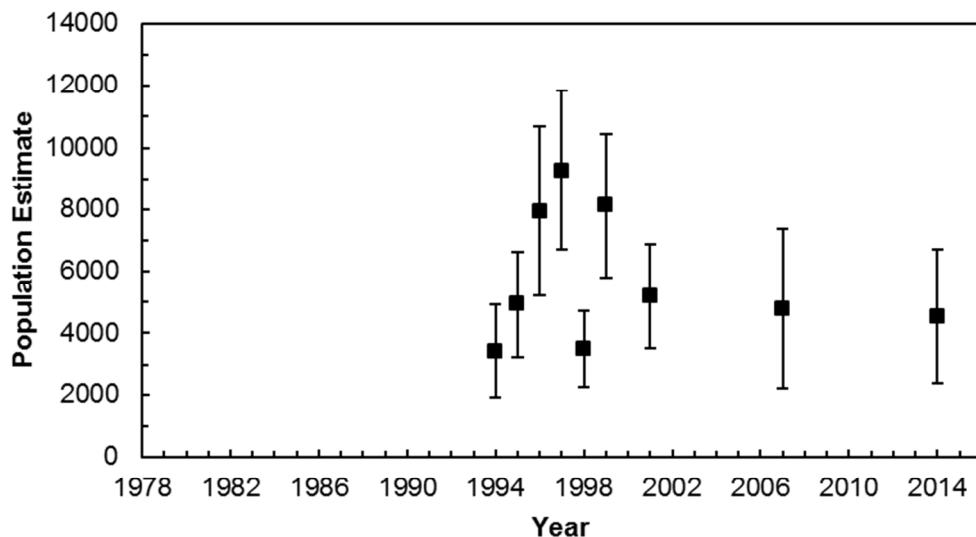


Fig. 31. Number of impala estimated to be in north-west Matabeleland since 1994

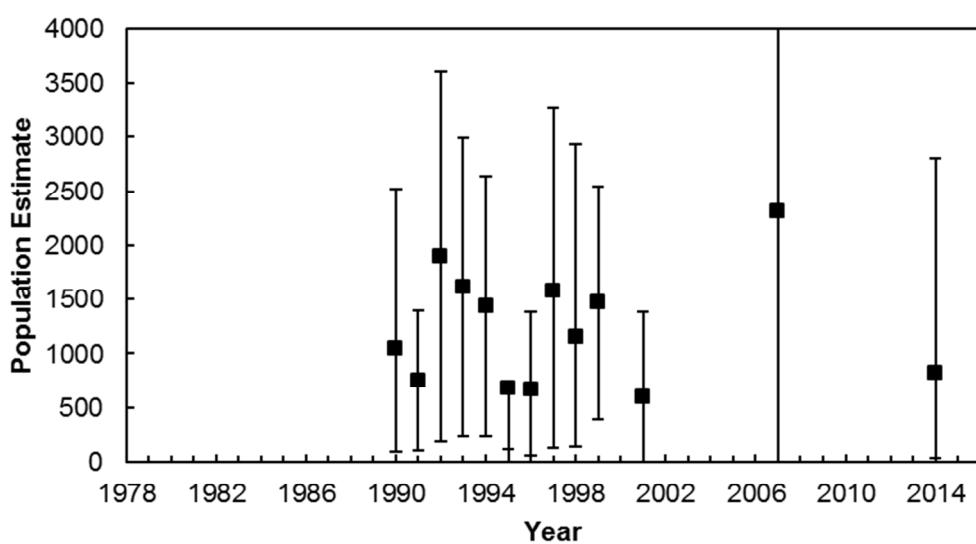


Fig. 32. Number of wildebeest estimated to be in north-west Matabeleland since 1990

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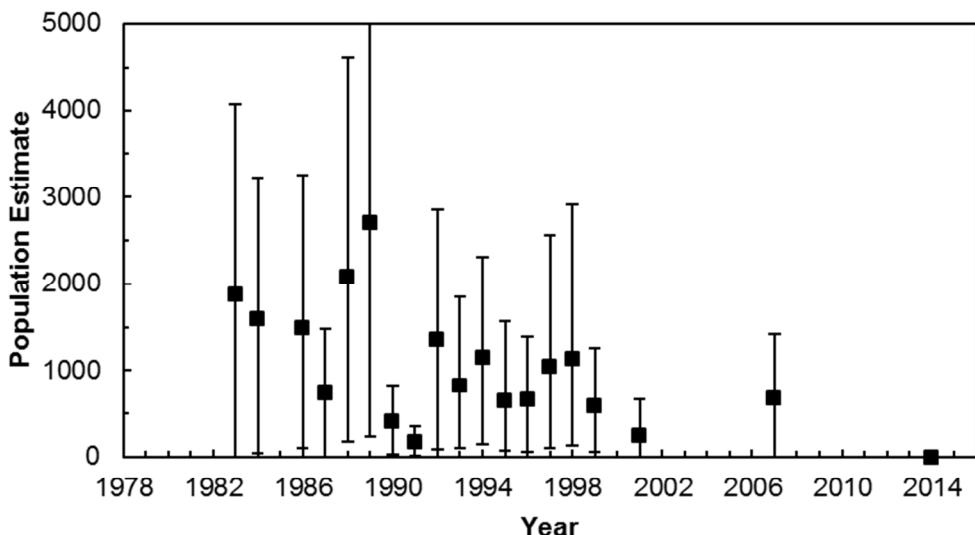


Fig. 33. Number of wildebeest estimated to be in Hwange NP since 1983

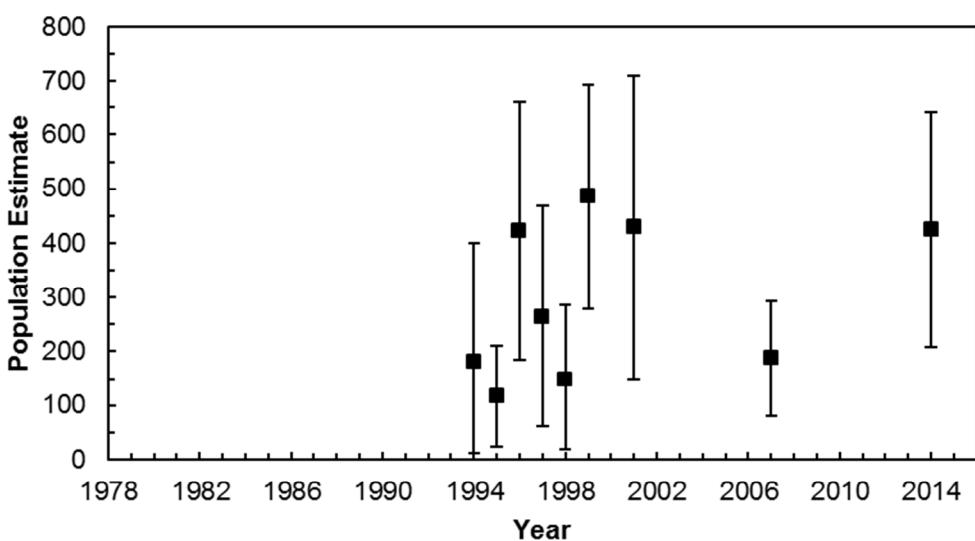


Fig. 34. Number of warthog estimated to be in Hwange NP since 1994

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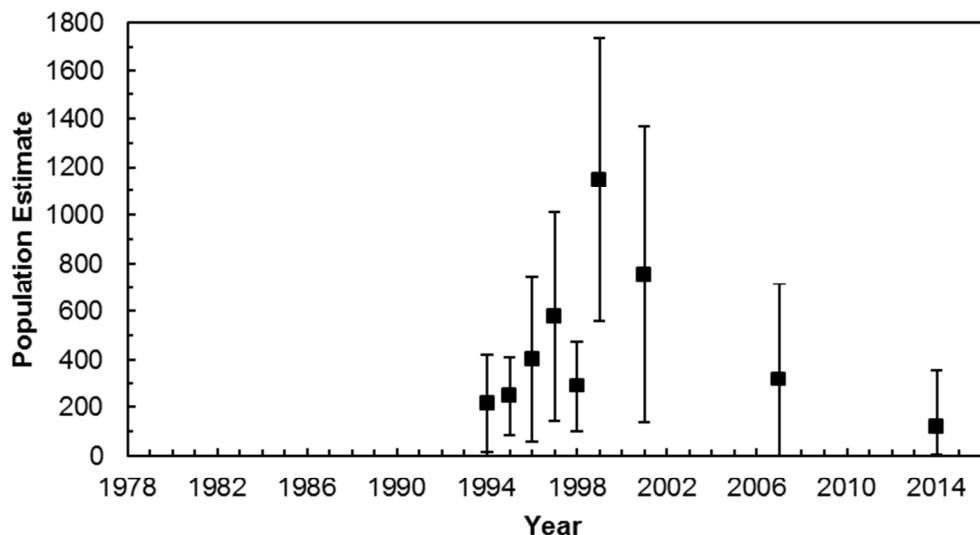


Fig. 35. Number of warthog estimated to be in the Matetsi complex since 1994

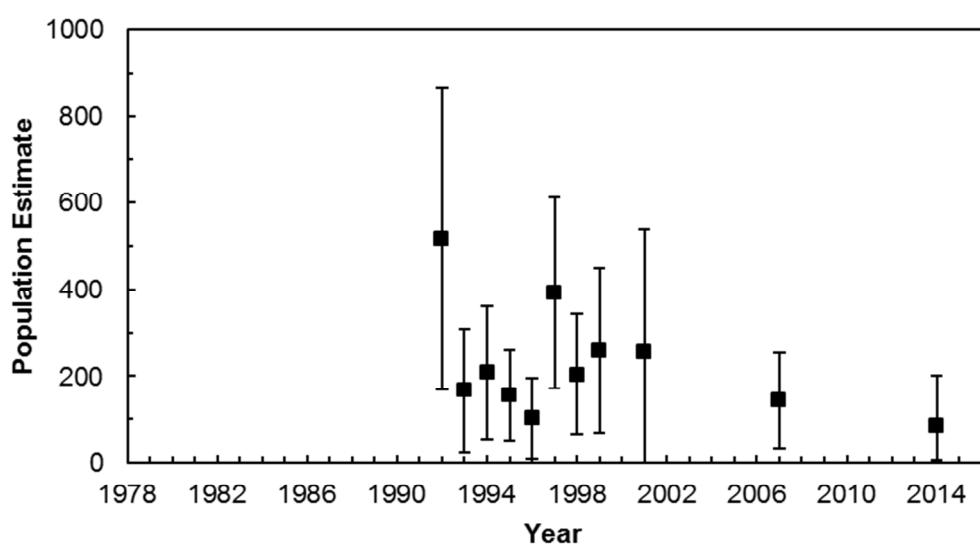


Fig. 36. Number of ostrich estimated to be in north-west Matabeleland since 1989

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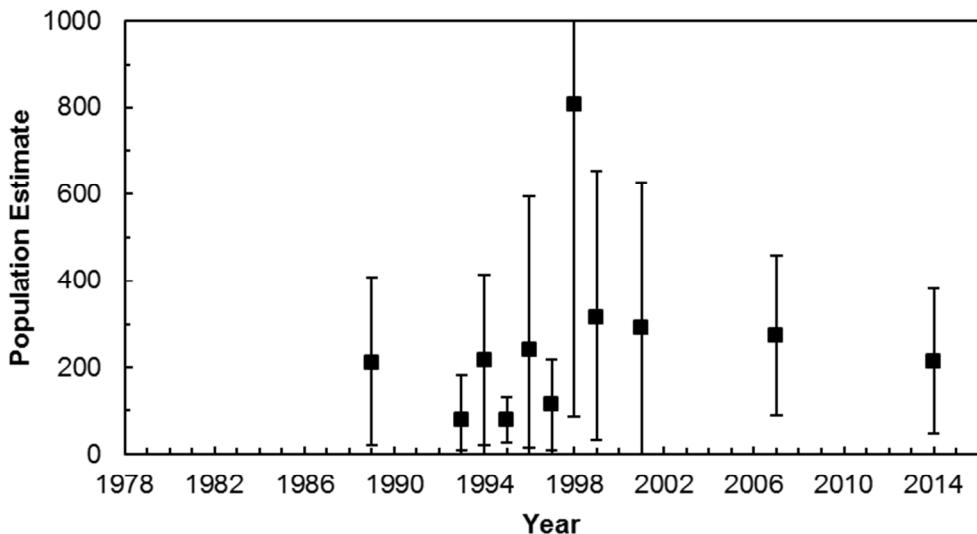


Fig. 37. Number of roan estimated to be in north-west Matabeleland since 1989

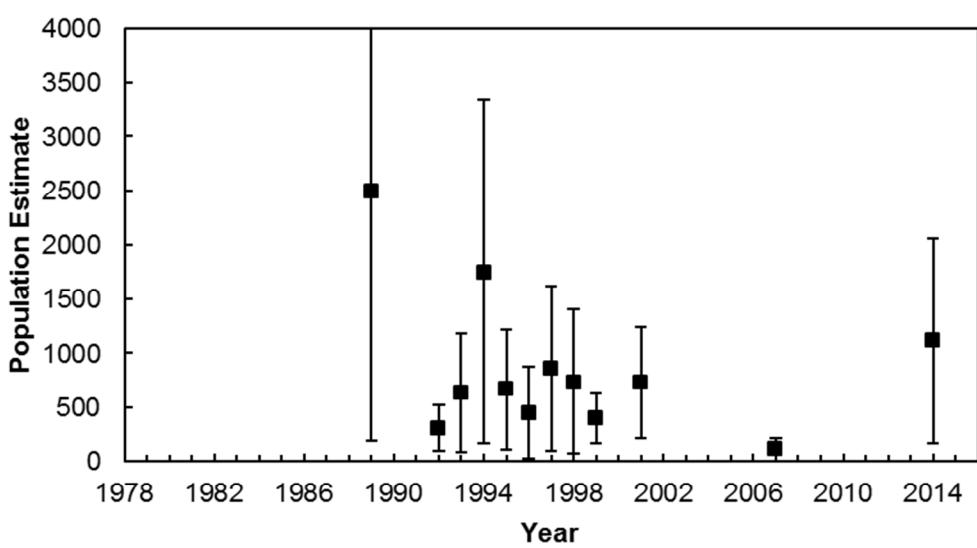


Fig. 38. Number of eland estimated to be in north-west Matabeleland since 1989

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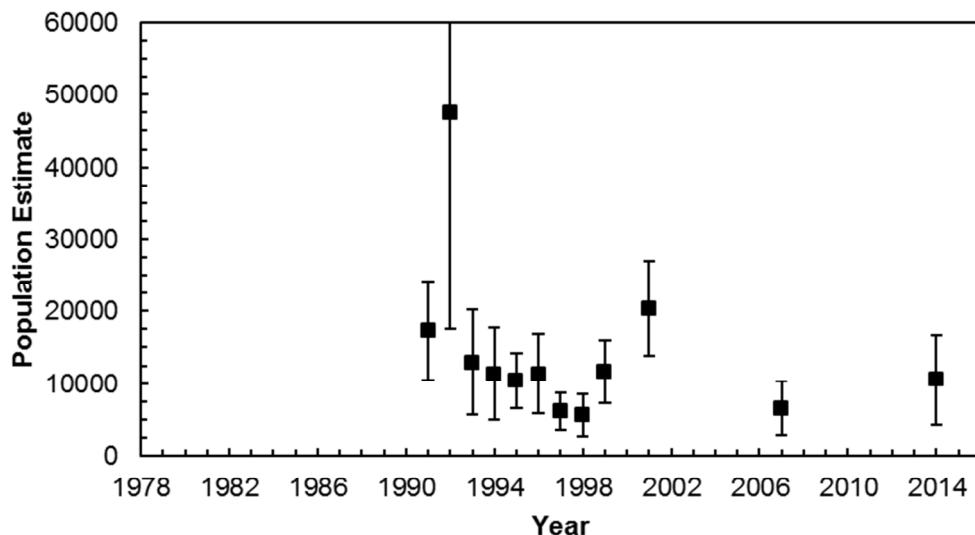


Fig. 39. Number of cattle estimated to be in north-west Matabeleland since 1991

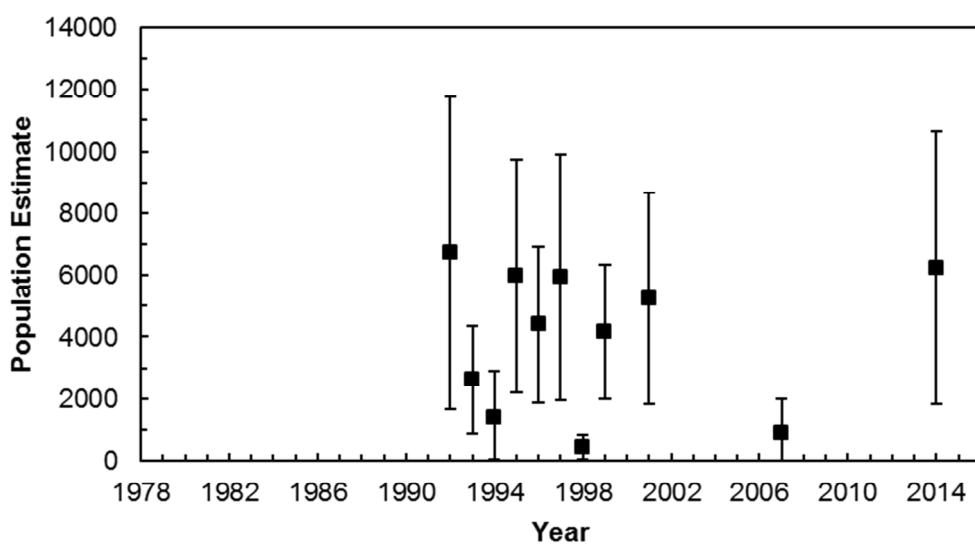


Fig. 40. Number of sheep and goats estimated to be in north-west Matabeleland since 1992

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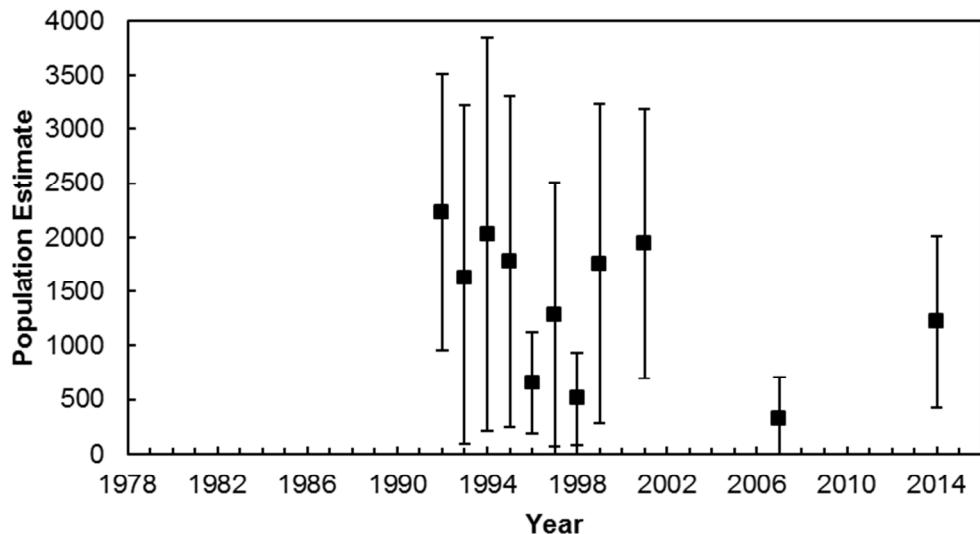


Fig. 41. Number of donkeys estimated to be in north-west Matabeleland since 1992

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Discussion

Elephants

There were estimated to be 53991 (+/- 7711) elephants in north-west Matabeleland during 2014, with 45846 (+/- 6316) of these in Hwange NP. The elephant population estimate has not changed significantly between the 2001 and 2014 surveys. This contrasts with the situation before 2001, when the elephant population was increasing. However, the number of elephant bulls has declined since 2001 in both Hwange NP and the Matetsi complex.

Elephant Carcasses

The 1+2 carcass ratio of 0.35 % during 2014 compares with a ratio of 0.21 % during 2001. The estimated number of all elephant carcasses regardless of age category (4132) represented an increase of 152 % since the 2001 survey. Hence, the all-carcass ratio has more than doubled, from 3.2 % during 2001 to 7.1 % during 2014. If it is assumed that all ‘unidentified’ carcasses were elephant carcasses, then the all-carcass ratio increased to 8.3 % during 2014, from 3.2 % during 2001. All these changes suggest that the elephant mortality rate has increased since 2001.

No poachers’ camps were seen during the survey. The absence of camps may indicate that poachers operate without bush camps, rather than that there is no poaching.

Other Large Herbivores

Whilst the populations of most other large herbivores had not changed since 2001, the temporal variation in population numbers since the start of the programme of aerial sample surveys suggests that, largely before 2001, there were declines in the numbers of buffalo, zebra and wildebeest in Hwange NP, and of sable and waterbuck in the Matetsi complex.

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Acknowledgements

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Table 5. Sampling statistics for the 2014 aerial survey of elephants and other large herbivores in north-west Matabeleland

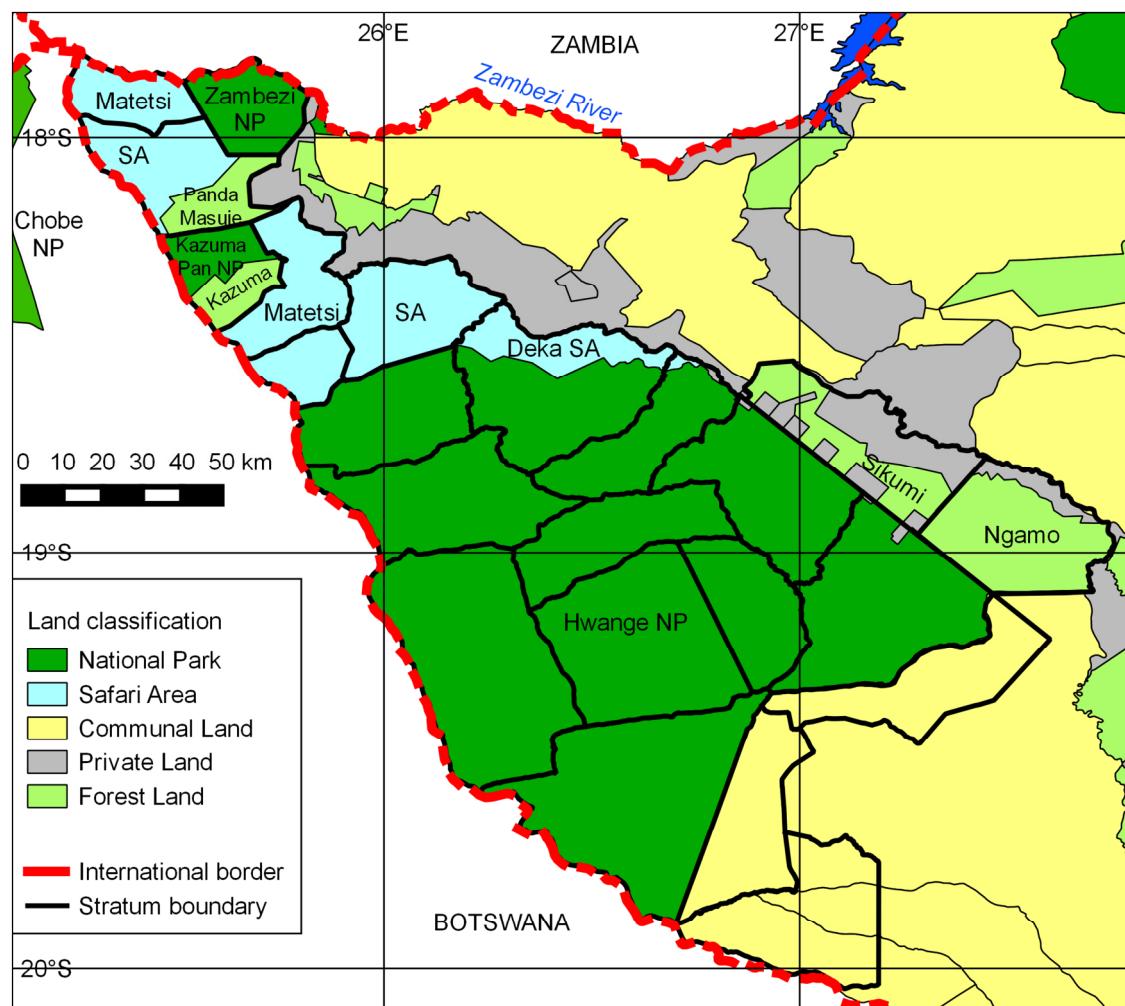
Stratum	Stratum area (km ²)	Transect spacing (km)	Transect orientation (°)	Number of transects [= n]	Percent of stratum sampled	Time and date sampled	Flying time (hours) ^a			Mean ground speed (km hour ⁻¹)	Mean search effort (minutes km ⁻²)
							Transect	Stratum	Total		
Zambezi NP	548	5.4	0	6	6	am 08/10/2014	0.57	1.00	1.60	179	1.09
Kazungula	437	3.4	0	10	9.2	am 08/10/2014	0.73	1.08	2.07	177	1.09
Panda Masuie	955	6.9	0	8	4.3	am 09/10/2014	0.82	1.37	3.00	168	1.20
Kazuma	551	7.9	0	4	4.1	pm 07/10/2014	0.42	0.67	2.07	172	1.13
Matetsi	697	8.8	-50 (130)	4	3.0	pm 08/10/2014	0.41	0.65	1.87	168	1.16
Rosslyn	349	5	90	4	6.2	pm 09/10/2014	0.41	0.58	1.72	175	1.12
Zanguja	847	7	29	6	4.5	pm 12/10/2014	0.75	1.15	2.20	167	1.18
Robins	1017	3.3	90	11	9.2	am 10/10/2014	1.83	2.42	3.43	171	1.17
Dandari	1279	2.5	0	29	12.2	am 15 & am 16/10/2014	3.00	3.92	5.17	171	1.15
Shakwanki	2148	4.5	90	15	6.8	am 17/10/2014	2.78	3.45	4.47	171	1.14
Dzivanini	2104	4	90	15	7.5	am 18/10/2014	3.02	0.92	1.92	175	1.15
Sinamatella	1511	3.2	0	18	9.8	am 12/10/2014	2.73	3.47	4.02	175	1.11
Mtoa	824	2.7	0	20	11.4	pm 13/10/2014	1.74	2.48	2.97	176	1.12
Main Camp	1253	3.5	41	14	8.7	am 13/10/2014	2.09	2.65	2.98	172	1.15
Shapi	913	2.2	0	26	13.9	am 16/10/2014	2.41	3.28	3.58	173	1.14
Central B	1720	4.6	-26 (154)	9	6.6	am 23/10/2014	2.25	2.60	3.30	168	1.19
Central A	769	4.4	66	10	6.9	pm 15/10/2014	1.02	1.38	2.00	173	1.14
Ngamo	1630	3.4	-52 (128)	17	8.9	am 22/10/2014	2.77	3.48	3.97	171	1.14
Tsholotsho East	914	8.4	90	7	3.7	pm 18/10/2014	0.64	1.12	2.18	173	1.12
Maitengwe	1203	10	0	6	3.4	pm 21/10/2014	0.77	1.22	2.35	176	1.13

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Stratum	Stratum area (km ²)	Transect spacing (km)	Transect orientation (°)	Number of transects sampled [= n]	Percent of stratum sampled	Time and date sampled		Flying time (hours) ^a		Mean ground speed (km hour ⁻¹)		Mean search effort (minutes km ⁻²)
						Transect	Stratum	Total	Transect	Stratum		
Tsholotsho North	958	10	0	8	2.9	pm 22/10/2014	0.54	1.07	2.03	175	1.16	
Ngamo Forest	1174	5.2	41	8	6.0	pm 17/10/2014	1.31	1.67	2.32	173	1.12	
Sikumi Forest	1158	7.9	41	7	3.7	pm 16/10/2014	0.79	1.17	1.73	175	1.12	
Total / Mean	24 959			7.1^b	33.8	42.8	62.9	173	1.14			

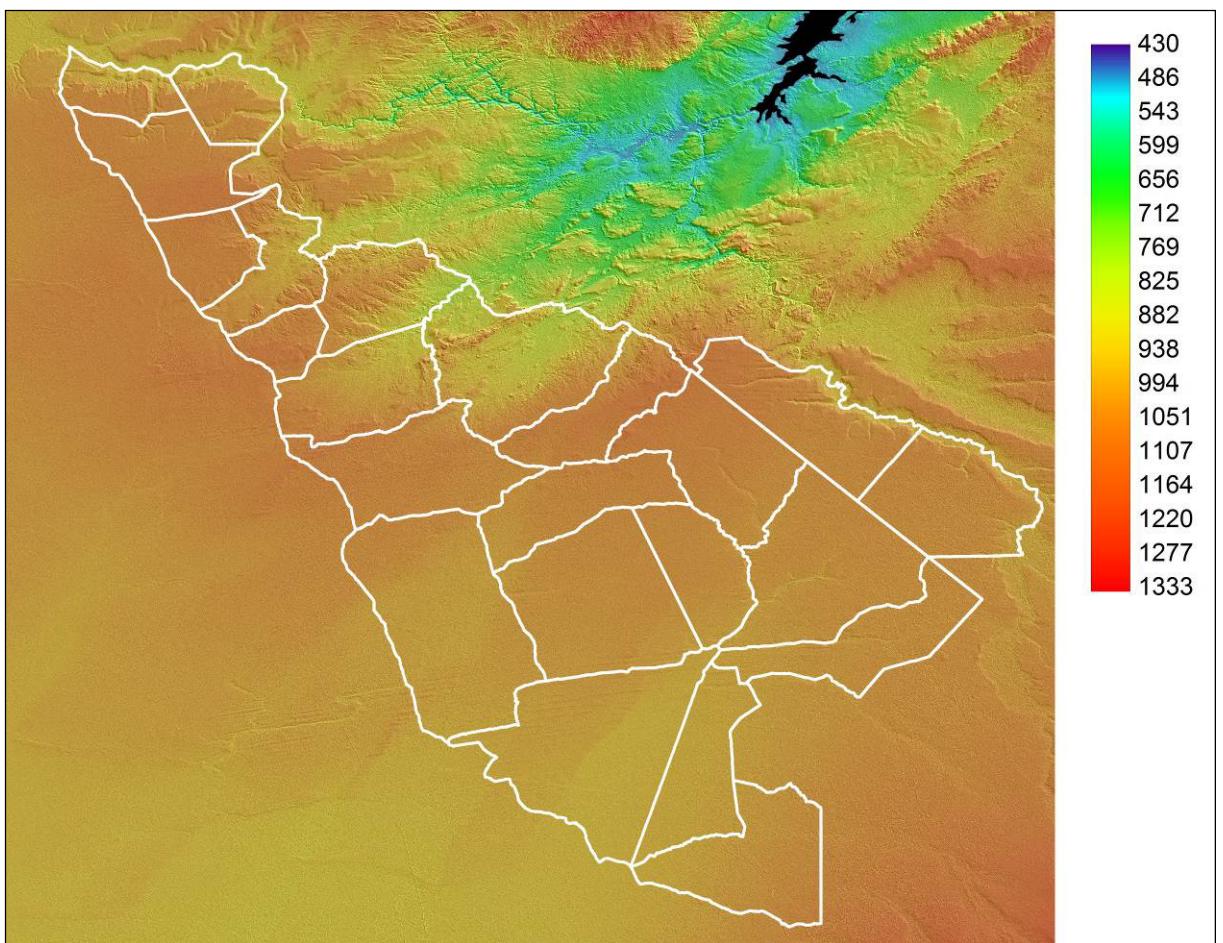
^a Transect time is the time spent searching the transects; stratum time is the transect time, plus the time spent travelling between transects in the same stratum; and total time is the stratum time, plus the time spent travelling between the stratum and the airstrip

^b Weighted mean, with stratum area as a proportion of the total area as weight



Map 2. Land designation in and around the 2014 north-west Matabeleland survey area

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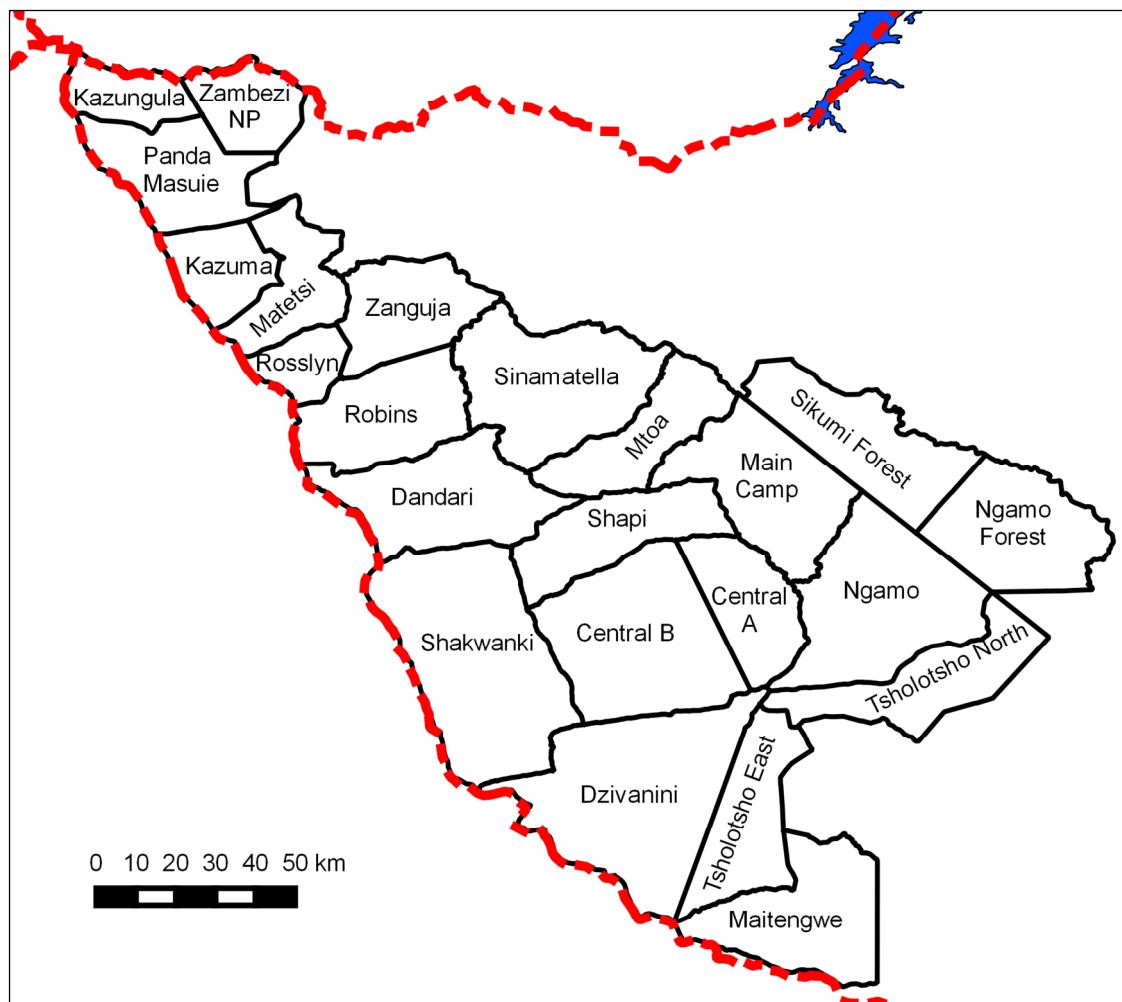


Map 3. Altitude in and around the north-west Matabeleland survey area

Lake Kariba is shown in black. Altitude is in meters. Bold white lines indicate stratum boundaries.

ASTER GDEM is a product of METI and NASA.

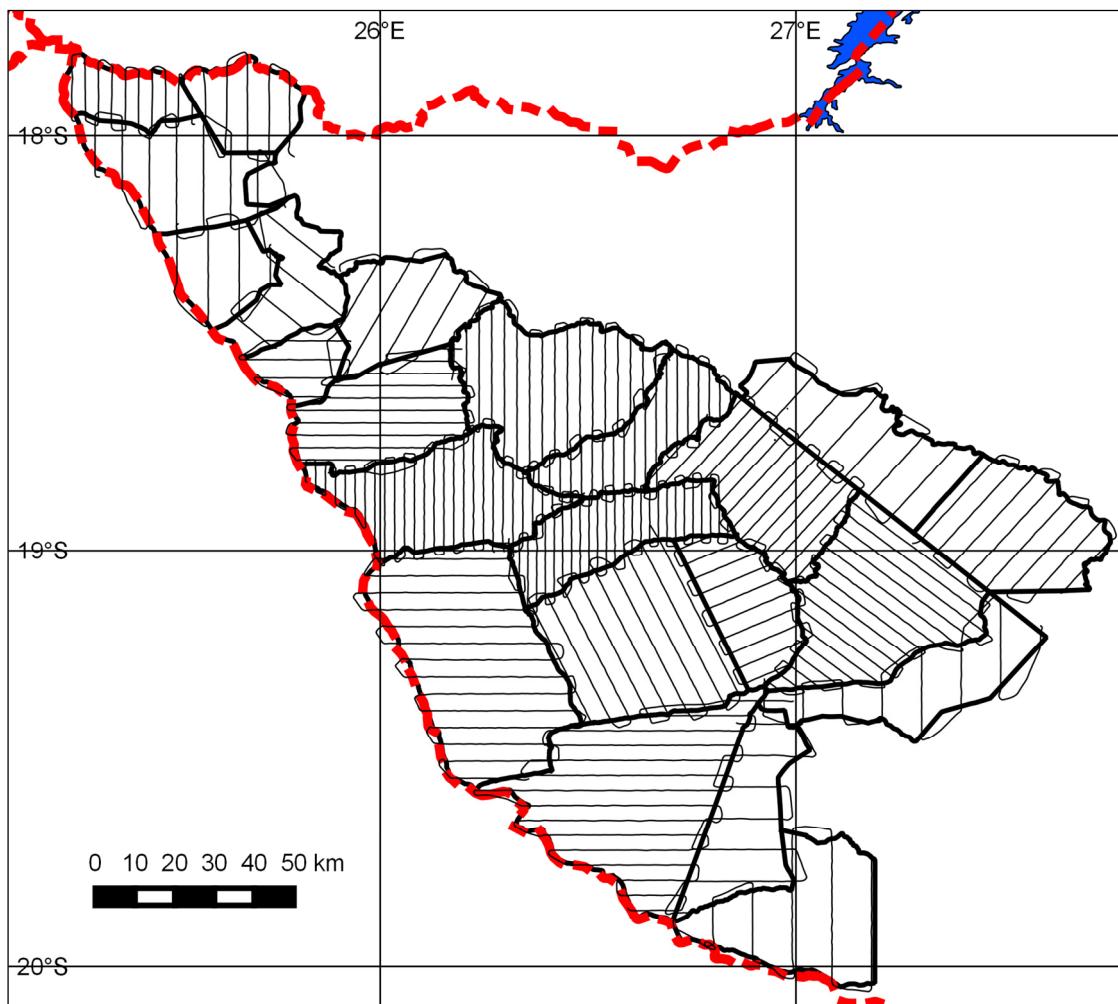
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Map 4. Strata used during the north-west Matabeleland aerial survey

Bold lines indicate stratum boundaries and labels give strata names. Lake Kariba is shown in blue and the red dashed lines indicate the international borders with Zambia to the north and Botswana to the west.

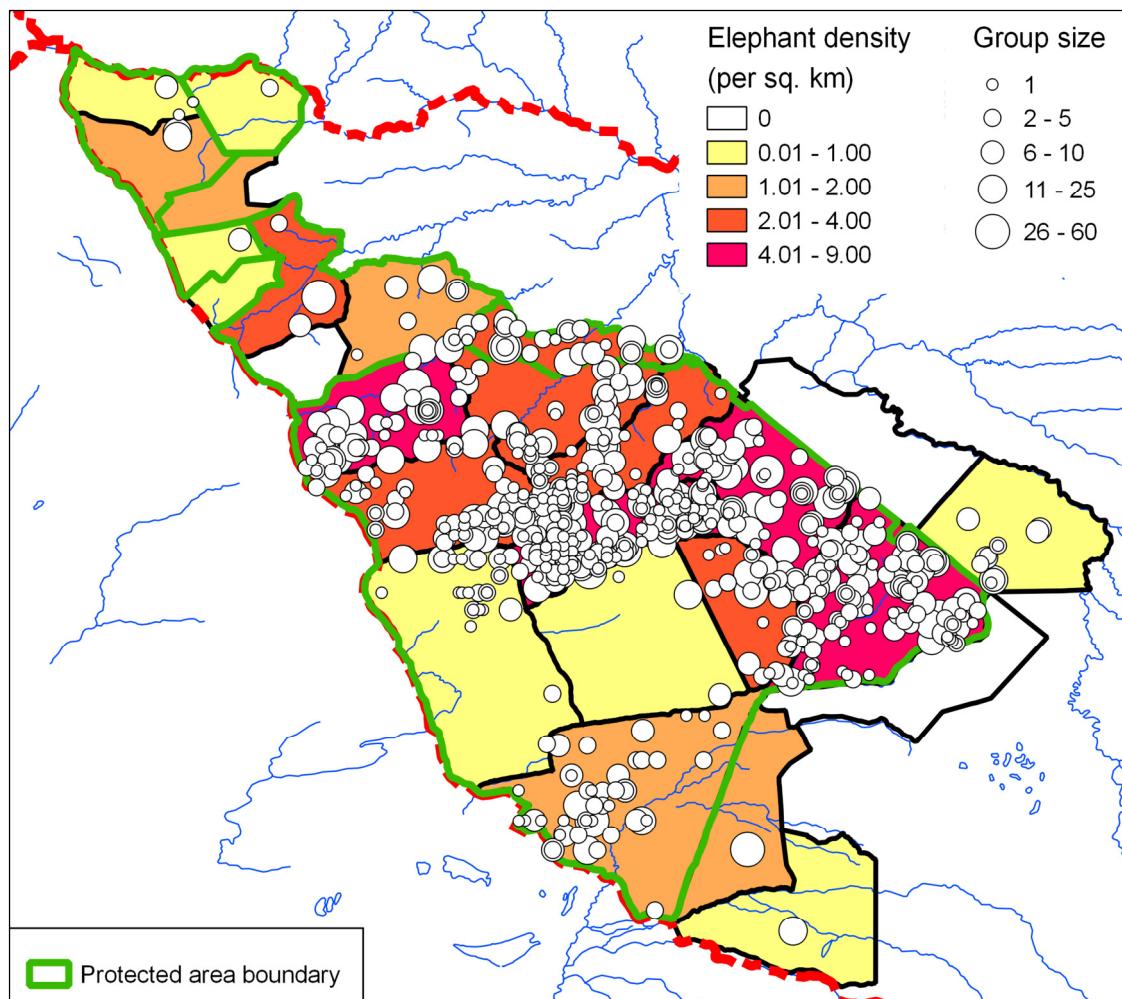
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Map 5. Tracklogs (flight lines) indicating the transects flown during the north-west Matabeleland aerial survey

Bold lines indicate stratum boundaries. Thin parallel lines indicate flight lines along the transects.

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Map 6. Distribution of elephant in north-west Matabeleland during October 2014

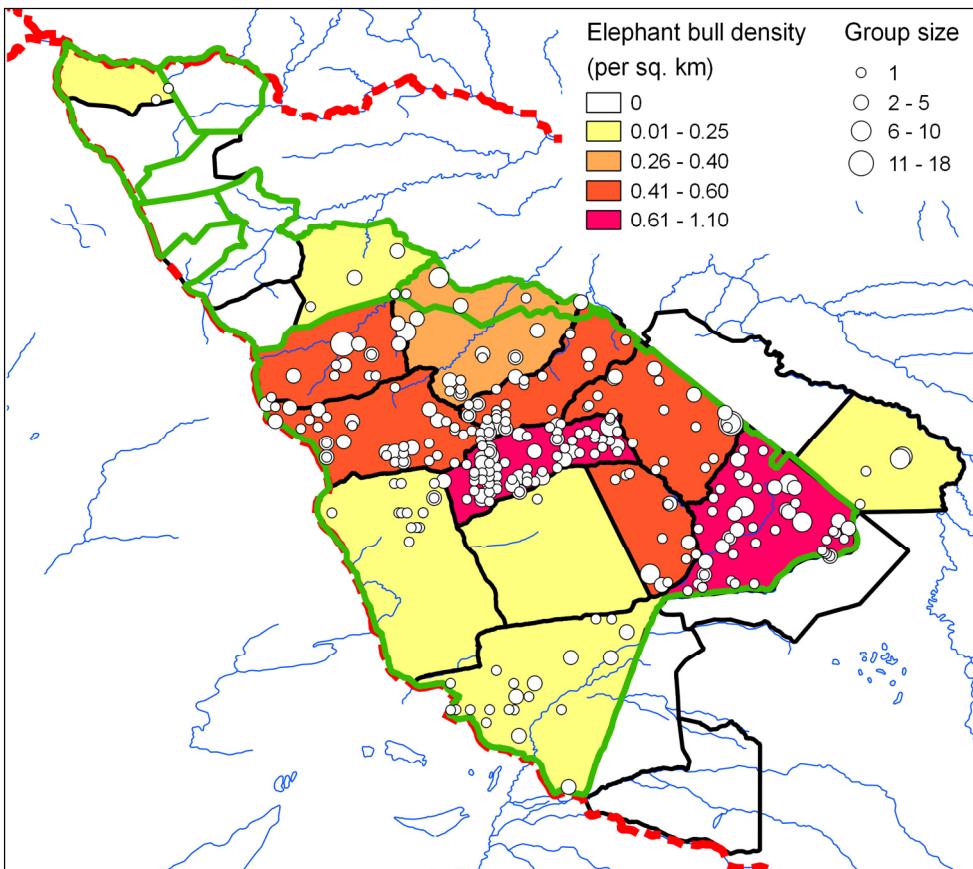
Colouring indicates the mean density of elephants within each stratum. The dots indicate the locations of elephants seen *within the search strips*, together with an indication of the size of each group. Small dots overlaying large dots indicate two or more groups of elephants in close proximity. Variation in dot density between strata reflects differences between strata in *both* the density of elephant groups *and* the sampling intensity (given in Table 5). The green lines indicates the boundaries of the protected areas. The red dashed line indicate the international border.

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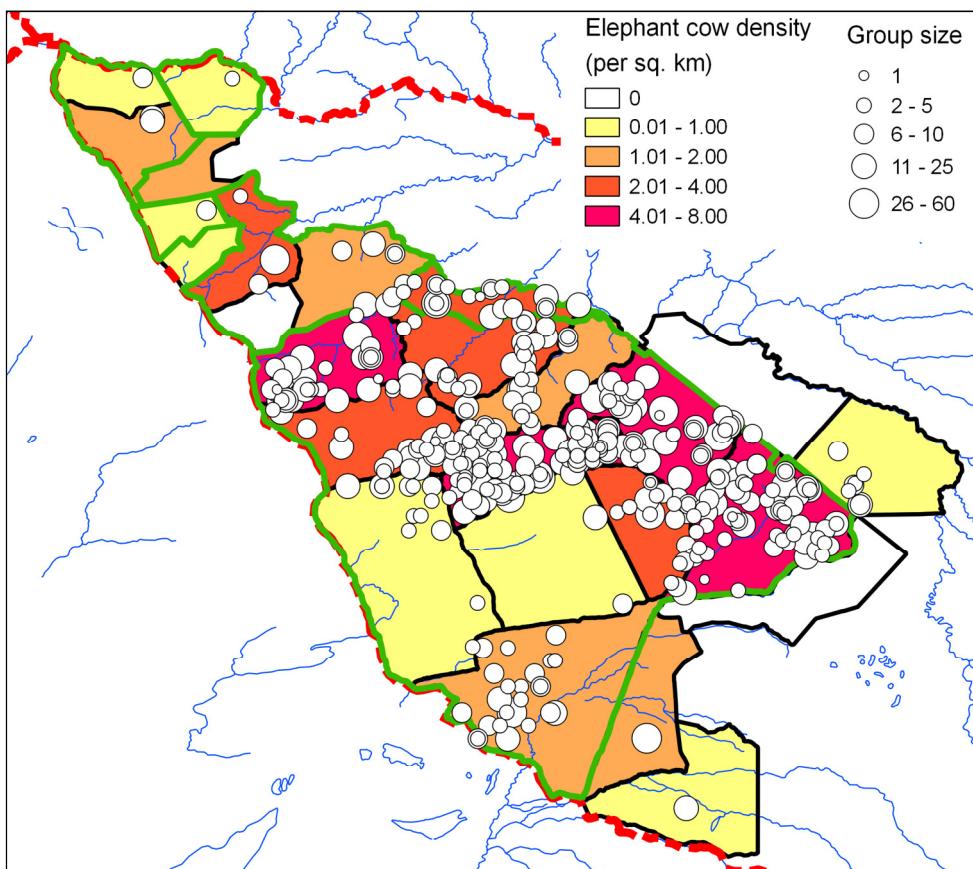
Table 6. Population estimates and statistics for Elephant in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	52	3	2287	236.5	3	175	0.09
Kazungula	151	14	13065	171.2	14	410	0.35
Panda Masuie	1400	60	1359107	196.9	60	4157	1.47
Kazuma	148	6	20164	305.3	6	600	0.27
Matetsi	1451	44	565962	165.0	44	3845	2.08
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	1641	74	332747	90.4	158	3124	1.94
Subtotals	4843	201	2293332	67.6	1571	8115	1.10
Hwange NP							
Robins	4941	454	932717	43.5	2789	7093	4.86
Dandari	4006	490	746573	44.2	2236	5776	3.13
Shakwanki	1355	92	529769	115.2	92	2916	0.63
Dzivanini	3198	240	598690	51.9	1538	4858	1.52
Sinamatella	4454	435	1121418	50.2	2220	6688	2.95
Mtoa	1947	221	381477	66.4	654	3240	2.36
Main Camp	7474	650	2510252	45.8	4052	10896	5.96
Shapi	7985	1113	1105192	27.1	5819	10151	8.75
Central B	487	32	119996	164.0	32	1286	0.28
Central A	2062	143	423366	71.4	590	3534	2.68
Ngamo	7937	709	1679420	34.6	5190	10684	4.87
Subtotals	45846	4579	10148869	13.8	39530	52162	3.02
Communal Areas							
Tsholotsho East	1468	55	2017598	236.8	55	4944	1.61
Maitengwe	733	25	423638	228.3	25	2406	0.61
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	2201	80	2441236	163.7	80	5804	0.72
Forest Areas							
Ngamo Forest	1101	66	256606	108.8	66	2299	0.94
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	1101	66	256606	108.8	66	2299	0.47
Totals	53991	4926	15140043	14.3	46280	61702	2.16

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Map 7. Distribution of elephant bulls in north-west Matabeleland during October 2014



Map 8. Distribution of elephant cows in north-west Matabeleland during October 2014

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Table 7. Population estimates and statistics for Elephant Bulls in north-west Matabeleland

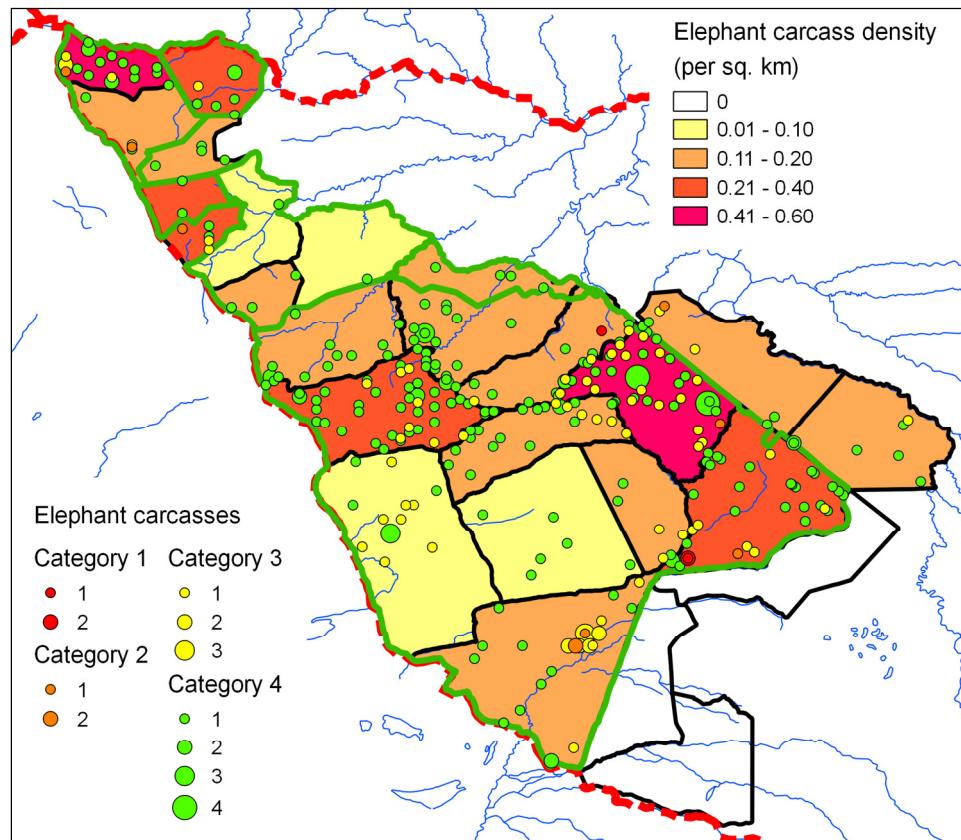
Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	43	4	1304	188.4	4	125	0.1
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	155	7	5276	120.3	7	342	0.18
Subtotals	199	11	6580	96.6	11	390	0.05
Hwange NP							
Robins	533	49	34121	77.2	122	945	0.52
Dandari	605	74	18492	46.0	326	883	0.47
Shakwanki	236	16	8914	86.0	33	438	0.11
Dzivanini	440	33	10576	50.2	219	660	0.21
Sinamatella	543	53	19946	54.9	245	841	0.36
Mtoa	370	42	13745	66.3	125	615	0.45
Main Camp	655	57	85110	96.1	57	1286	0.52
Shapi	990	138	61763	51.7	478	1502	1.08
Central B	15	1	228	228.6	1	50	0.01
Central A	332	23	22873	103.2	23	674	0.43
Ngamo	1063	95	31956	35.6	685	1442	0.65
Subtotals	5782	581	307725	19.1	4680	6884	0.38
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	250	15	55985	223.6	15	810	0.21
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	250	15	55985	223.6	15	810	0.11
Totals	6231	607	370290	19.4	5022	7439	0.25

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Table 8. Population estimates and statistics for Elephant Cows in north-west Matabeleland

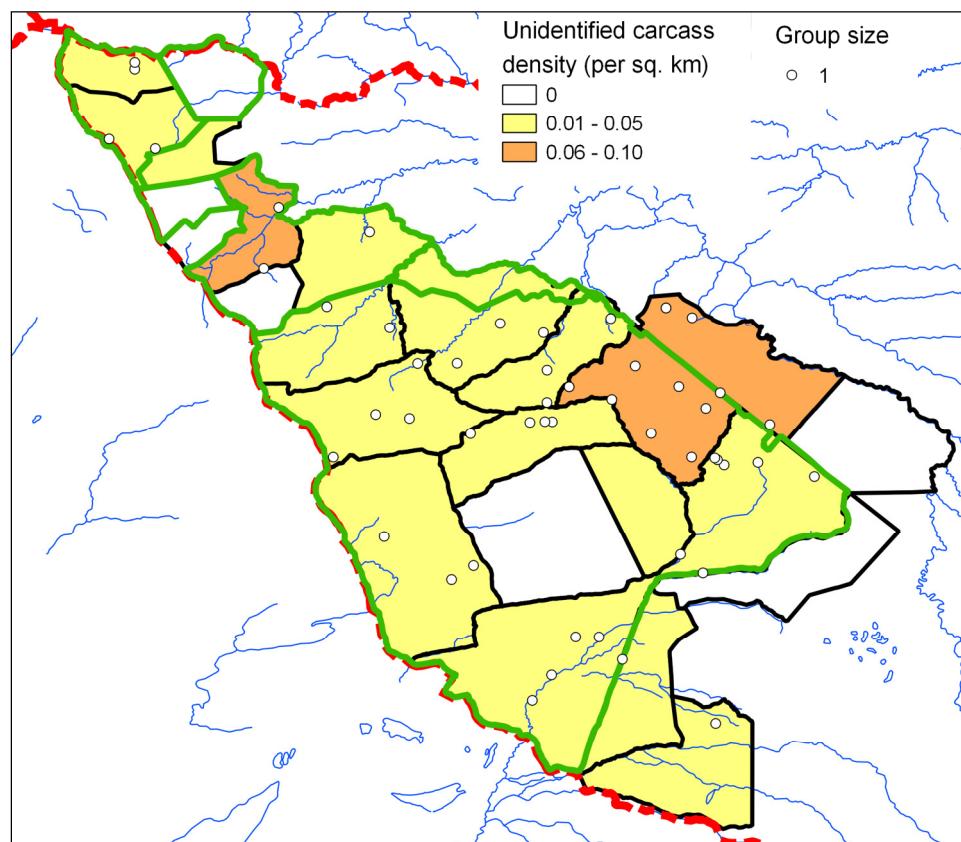
Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	52	3	2287	236.6	3	175	0.09
Kazungula	108	10	11761	226.3	10	354	0.25
Panda Masuie	1400	60	1359107	196.9	60	4158	1.47
Kazuma	148	6	20164	305.4	6	600	0.27
Matetsi	1451	44	565962	165.0	44	3845	2.08
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	1486	67	327471	99.0	67	2957	1.75
Subtotals	4646	190	2286752	70.3	1379	7912	1.06
Hwange NP							
Robins	4408	405	898596	47.9	2296	6520	4.33
Dandari	3401	416	728081	51.4	1653	5148	2.66
Shakwanki	1119	76	520854	138.4	76	2667	0.52
Dzivanini	2758	207	588113	59.6	1113	4403	1.31
Sinamatella	3911	382	1101471	56.6	1696	6125	2.59
Mtoa	1577	179	367732	80.5	308	2846	1.91
Main Camp	6819	593	2425142	49.3	3456	10183	5.44
Shapi	6995	975	1043429	30.1	4891	9099	7.66
Central B	472	31	119768	169.0	31	1270	0.27
Central A	1730	120	400493	82.7	299	3162	2.25
Ngamo	6874	614	1647464	39.6	4152	9595	4.22
Subtotals	40063	3998	9841144	15.5	33844	46283	2.64
Communal Areas							
Tsholotsho East	1468	55	2017598	236.8	55	4943	1.61
Maitengwe	733	25	423638	228.2	25	2407	0.61
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	2201	80	2441236	163.7	80	5804	0.72
Forest Areas							
Ngamo Forest	851	51	200621	124.5	51	1910	0.72
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	851	51	200621	124.5	51	1910	0.36
Totals	47761	4319	14769753	15.9	40143	55378	1.91

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Map 9. Distribution of elephant carcasses in north-west Matabeleland during October 2014

Size of circle indicates number of carcasses in group



Map 10. Distribution of unidentified carcasses in north-west Matabeleland during October 2014

Table 9. Population estimates and statistics for Elephant Carcass 1 in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	0	0	0	0.0	0	0	0
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	0	0	0	0.0	0	0	0
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	9	1	67	195.1	1	26	0.01
Main Camp	0	0	0	0.0	0	0	0
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	34	3	1043	203.9	3	102	0.02
Subtotals	42	4	1111	165.2	4	112	0.003
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	42	4	1111	165.2	4	112	0.002

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Table 10. Population estimates and statistics for Elephant Carcass 2 in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	11	1	118	226.5	1	35	0.02
Panda Masuie	23	1	430	210.1	1	72	0.02
Kazuma	25	1	506	290.2	1	96	0.04
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	59	3	1054	124.8	3	132	0.01
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	0	0	0	0.0	0	0	0
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	40	3	780	149.8	3	100	0.02
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	0	0	0	0.0	0	0	0
Main Camp	11	1	132	215.5	1	36	0.01
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	11	1	109	197.4	1	33	0.007
Subtotals	63	5	1020	105.7	5	129	0.004
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	27	1	823	257.4	1	97	0.02
Subtotals	27	1	823	257.4	1	97	0.01
Totals	149	9	2897	73.9	39	259	0.01

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Table 11. Population estimates and statistics for Elephant Carcass 3 in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	17	1	244	231.6	1	57	0.03
Kazungula	43	4	1105	173.4	4	119	0.1
Panda Masuie	23	1	430	210.1	1	72	0.02
Kazuma	49	2	2240	305.4	2	200	0.09
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	133	8	4019	109.6	8	280	0.03
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	57	7	471	77.7	13	102	0.04
Shakwanki	118	8	1872	78.8	25	211	0.05
Dzivanini	200	15	11127	113.2	15	426	0.09
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	35	4	246	93.1	4	68	0.04
Main Camp	230	20	3471	55.3	103	357	0.18
Shapi	43	6	242	74.4	11	75	0.05
Central B	0	0	0	0.0	0	0	0
Central A	58	4	1028	125.7	4	130	0.07
Ngamo	56	5	580	91.2	5	107	0.03
Subtotals	797	69	19036	35.2	517	1077	0.05
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	17	1	292	242.2	1	57	0.01
Sikumi Forest	55	2	1479	172.5	2	149	0.05
Subtotals	71	3	1771	136.2	3	168	0.03
Totals	1001	80	24826	31.6	685	1318	0.04

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Table 12. Population estimates and statistics for Elephant Carcass 4 in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	104	6	2988	135.2	6	244	0.19
Kazungula	184	17	1556	48.4	95	273	0.42
Panda Masuie	140	6	2283	80.7	27	253	0.15
Kazuma	99	4	1319	117.2	4	214	0.18
Matetsi	33	1	1030	309.8	1	135	0.05
Rosslyn	48	3	1079	216.9	3	153	0.14
Zanguja	22	1	456	247.5	1	77	0.03
Subtotals	630	38	10712	33.7	418	843	0.14
Hwange NP							
Robins	152	14	1865	63.2	56	249	0.15
Dandari	368	45	3194	31.5	252	484	0.29
Shakwanki	88	6	1899	105.8	6	182	0.04
Dzivanini	160	12	1656	54.6	73	247	0.08
Sinamatella	266	26	6150	62.2	101	432	0.18
Mtoa	123	14	1755	71.1	36	211	0.15
Main Camp	356	31	7998	54.2	163	550	0.28
Shapi	129	18	665	41.2	76	182	0.14
Central B	91	6	1052	81.8	17	166	0.05
Central A	58	4	559	92.7	4	111	0.07
Ngamo	291	26	5262	52.8	137	445	0.18
Subtotals	2084	202	32056	17.1	1728	2439	0.14
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	117	7	2533	101.9	7	236	0.1
Sikumi Forest	109	4	5205	161.8	4	286	0.09
Subtotals	226	11	7739	85.7	32	420	0.10
Totals	2940	251	50506	15.1	2495	3385	0.12

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Table 13. Population estimates and statistics for Unidentified Carcasses in north-west Matabeleland

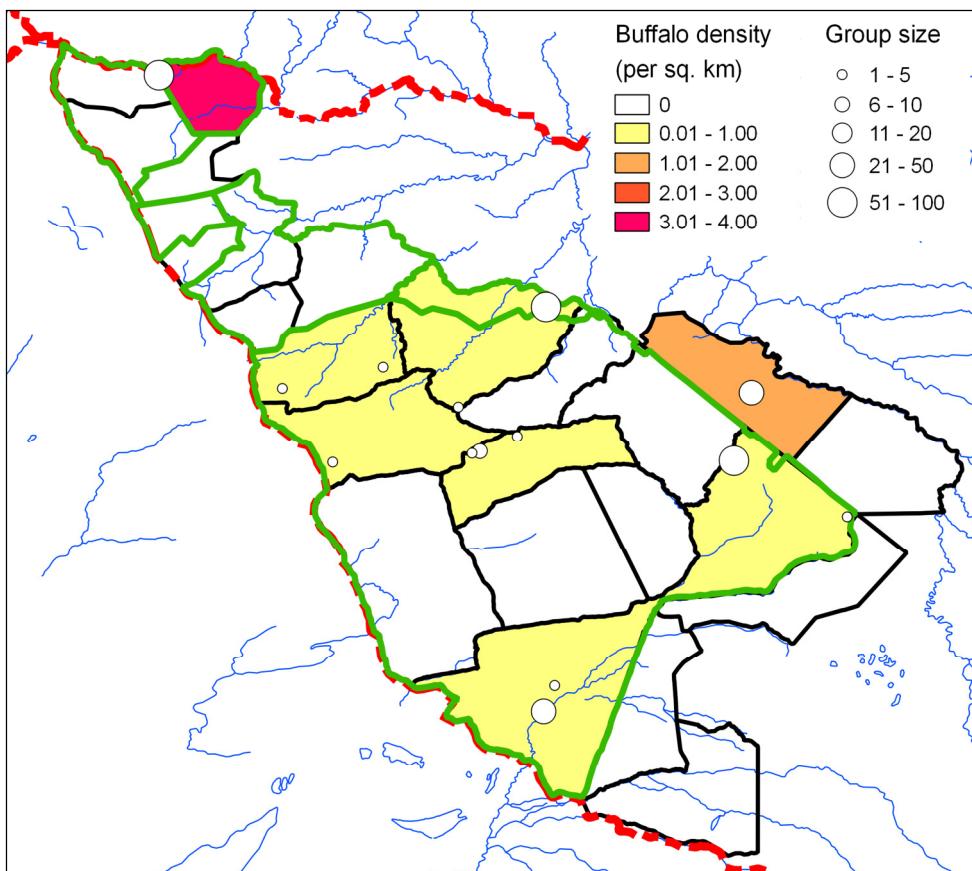
Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	22	2	441	219.2	2	69	0.05
Panda Masuie	47	2	671	131.2	2	108	0.05
Kazuma	0	0	0	0.0	0	0	0
Matetsi	66	2	1528	188.6	2	190	0.09
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	22	1	368	222.4	1	71	0.03
Subtotals	156	7	3008	78.1	34	279	0.04
Hwange NP							
Robins	22	2	189	140.7	2	52	0.02
Dandari	33	4	177	83.3	5	60	0.03
Shakwanki	44	3	469	105.2	3	91	0.02
Dzivanini	53	4	885	119.7	4	117	0.03
Sinamatella	31	3	237	105.7	3	63	0.02
Mtoa	26	3	322	142.1	3	64	0.03
Main Camp	92	8	1149	79.6	19	165	0.07
Shapi	36	5	189	78.9	8	64	0.04
Central B	0	0	0	0.0	0	0	0
Central A	14	1	221	233.2	1	48	0.02
Ngamo	67	6	1001	99.9	6	134	0.04
Subtotals	419	39	4839	33.0	280	557	0.03
Communal Areas							
Tsholotsho East	27	1	743	250.0	1	93	0.03
Maitengwe	29	1	604	215.4	1	93	0.02
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	56	2	1347	146.0	2	138	0.02
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	109	4	3798	138.2	4	260	0.09
Subtotals	109	4	3798	138.2	4	260	0.05
Totals	740	52	12992	31.0	511	970	0.03

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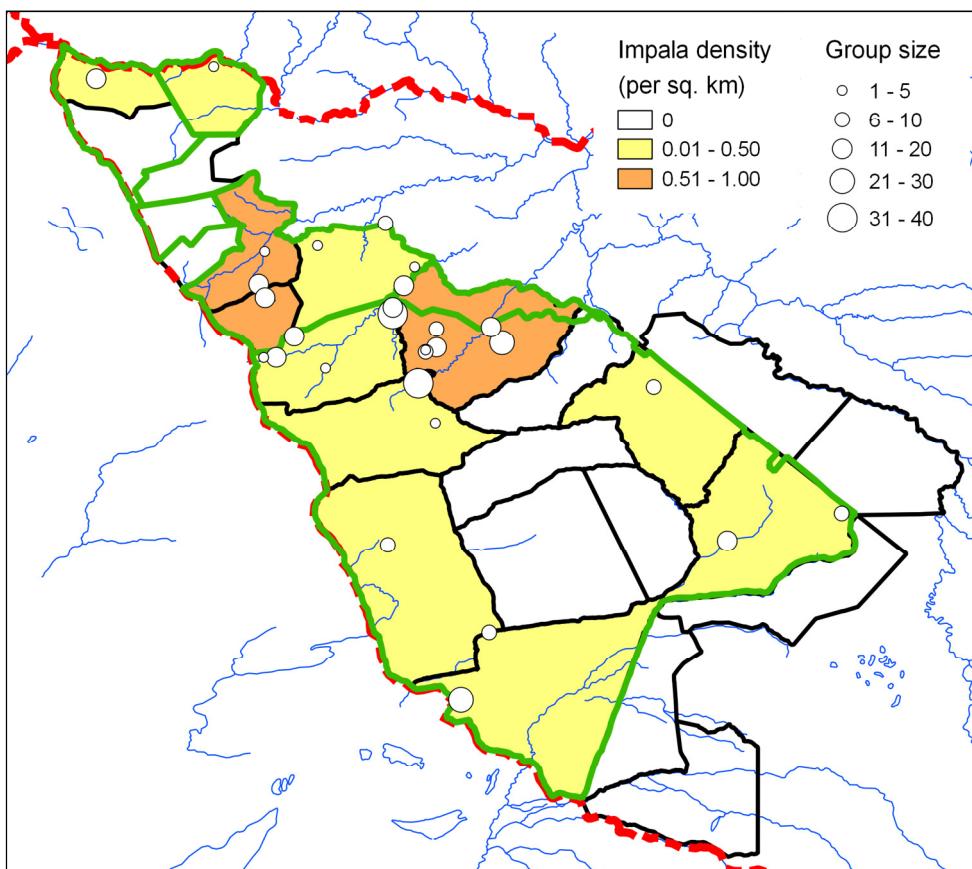
Table 14. Elephant carcass ratios in north-west Matabeleland

Stratum	1+2 carcass ratio (elephant carcasses in age category 1 or 2)	All-carcass ratio (all elephant carcasses)	All-carcass ratio (all elephant carcasses and unidentified carcasses)
Matetsi Complex			
Zambezi NP	0.00	70.0	70.0
Kazungula	6.70	61.2	63.3
Panda Masuie	1.64	11.8	14.3
Kazuma	14.28	53.8	53.8
Matetsi	0.00	2.2	6.4
Rosslyn	-	100.0	100.0
Zanguja	0.00	1.3	2.6
Entire complex	1.20	14.5	16.8
Hwange NP			
Robins	0.00	3.0	3.4
Dandari	0.00	9.6	10.3
Shakwanki	0.00	13.2	15.6
Dzivanini	1.23	11.1	12.4
Sinamatella	0.00	5.6	6.2
Mtoa	0.45	7.9	9.1
Main Camp	0.15	7.4	8.5
Shapi	0.00	2.1	2.5
Central B	0.00	15.8	15.8
Central A	0.00	5.3	5.9
Ngamo	0.56	4.7	5.5
Entire NP	0.23	6.1	6.9
Communal Areas			
Tsholotsho East	0.00	0.0	1.8
Maitengwe	0.00	0.0	3.8
Tsholotsho North	-	-	-
All Communal Areas	0.00	0.0	2.5
Forest Areas			
Ngamo Forest	0.00	10.8	10.8
Sikumi Forest	100.00	100.0	100.0
All Forest Areas	2.42	22.8	28.3
NW Matabeleland	0.35	7.1	8.3

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Map 11. Distribution of buffalo in north-west Matabeleland during October 2014



Map 12. Distribution of impala in north-west Matabeleland during October 2014

Table 15. Population estimates and statistics for Buffalo in north-west Matabeleland

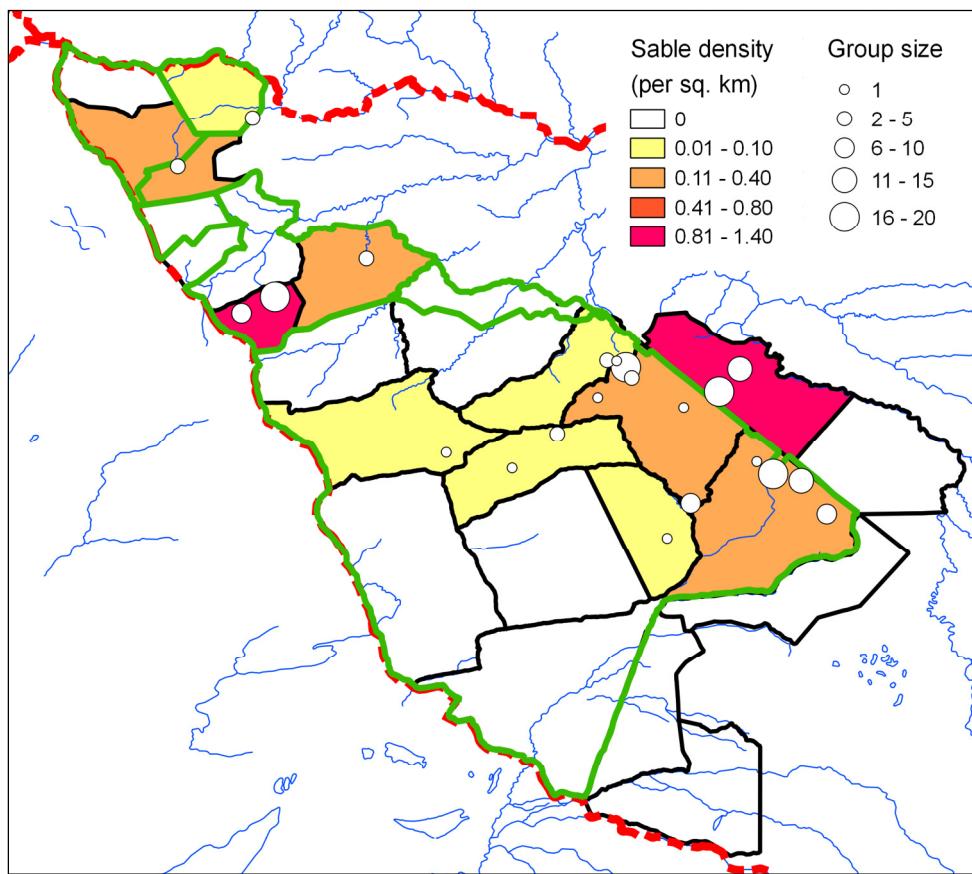
Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	1733	100	3816238	289.9	100	6755	3.16
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	1733	100	3816238	289.8	100	6754	0.40
Hwange NP							
Robins	109	10	4043	130.2	10	251	0.11
Dandari	8	1	57	188.9	1	24	0.006
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	680	51	431552	207.4	51	2089	0.32
Sinamatella	635	62	338604	193.4	62	1863	0.42
Mtoa	0	0	0	0.0	0	0	0
Main Camp	0	0	0	0.0	0	0	0
Shapi	72	10	2264	136.6	10	170	0.08
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	683	61	353138	184.5	61	1943	0.42
Subtotals	2186	195	1129658	97.9	195	4327	0.14
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	1228	45	1511530	245.1	45	4236	1.06
Subtotals	1228	45	1511530	245.1	45	4236	0.53
Totals	5146	340	6457426	107.6	340	10683	0.21

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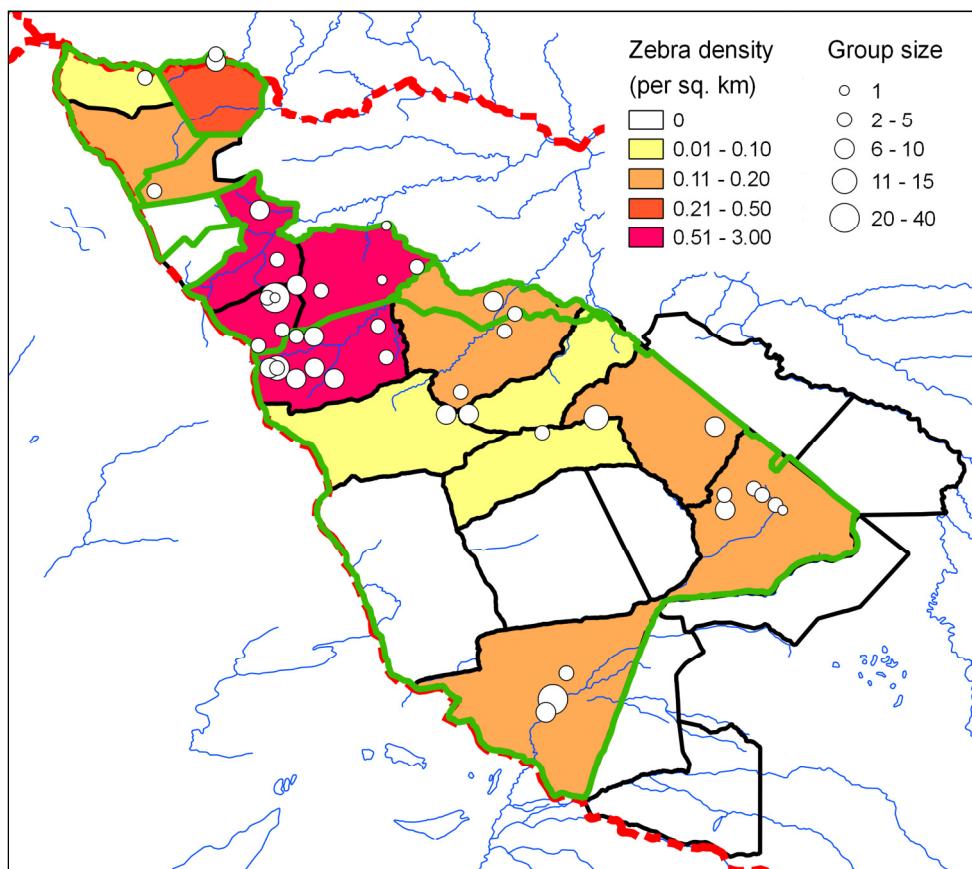
Table 16. Population estimates and statistics for Impala in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	17	1	237	228.4	1	57	0.03
Kazungula	163	15	25835	223.6	15	526	0.37
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	594	18	247271	266.6	18	2176	0.85
Rosslyn	241	15	76869	366.1	15	1123	0.69
Zanguja	333	15	27223	127.5	15	757	0.39
Subtotals	1347	64	377435	111.6	64	2850	0.31
Hwange NP							
Robins	446	41	56008	118.2	41	973	0.44
Dandari	335	41	89016	182.3	41	946	0.26
Shakwanki	236	16	24222	141.7	16	569	0.11
Dzivanini	333	25	109974	213.5	25	1044	0.16
Sinamatella	1474	144	440943	95.0	144	2875	0.98
Mtoa	0	0	0	0.0	0	0	0
Main Camp	115	10	13469	218.0	10	366	0.09
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	246	22	28211	144.6	22	602	0.15
Subtotals	3186	299	761844	55.2	1426	4945	0.21
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	4533	363	1139279	47.8	2368	6697	0.18

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Map 13. Distribution of sable in north-west Matabeleland during October 2014



Map 14. Distribution of zebra in north-west Matabeleland during October 2014

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Table 17. Population estimates and statistics for Sable in north-west Matabeleland

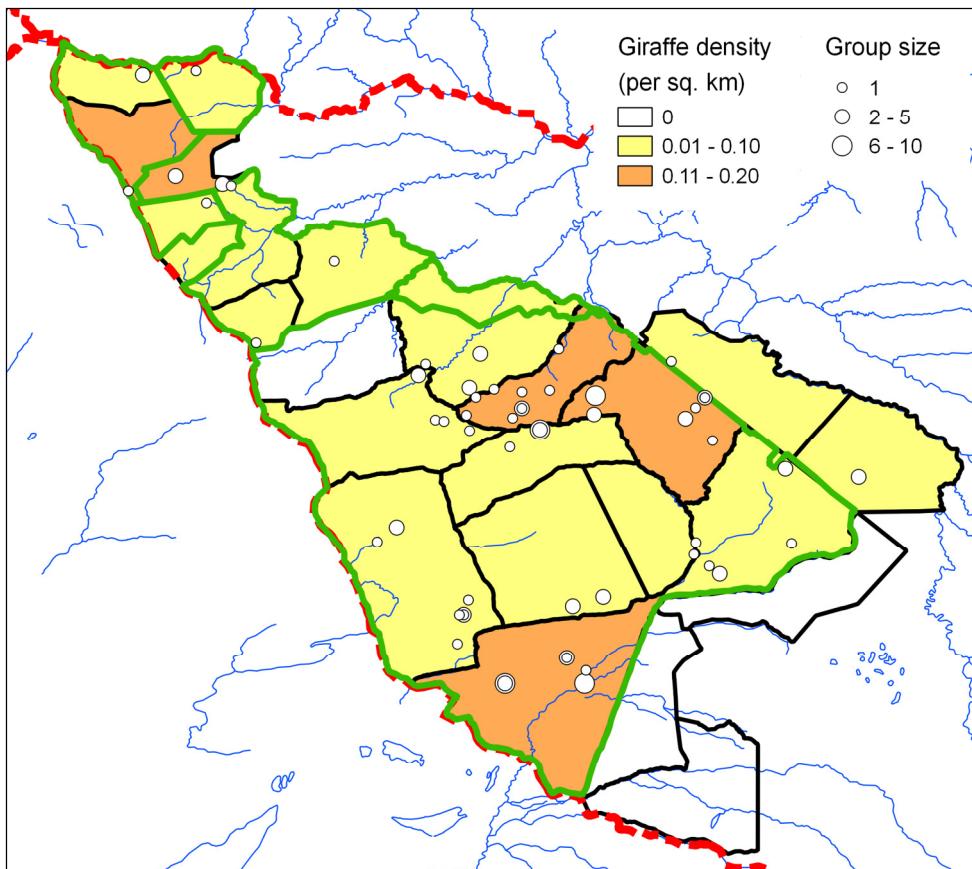
Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	35	2	1241	261.4	2	125	0.06
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	117	5	9717	199.8	5	350	0.12
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	450	28	113742	238.6	28	1523	1.29
Zanguja	111	5	9199	222.4	5	357	0.13
Subtotals	712	40	133899	142.7	40	1728	0.16
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	8	1	58	190.6	1	24	0.006
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	0	0	0	0.0	0	0	0
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	26	3	326	142.9	3	64	0.03
Main Camp	356	31	59695	148.0	31	884	0.28
Shapi	22	3	221	142.1	3	52	0.02
Central B	0	0	0	0.0	0	0	0
Central A	14	1	201	222.3	1	46	0.02
Ngamo	493	44	103593	138.5	44	1175	0.3
Subtotals	920	83	164093	90.2	90	1749	0.06
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	955	35	898564	242.9	35	3274	0.82
Subtotals	955	35	898564	242.9	35	3274	0.41
Totals	2586	158	1196557	94.2	158	5024	0.10

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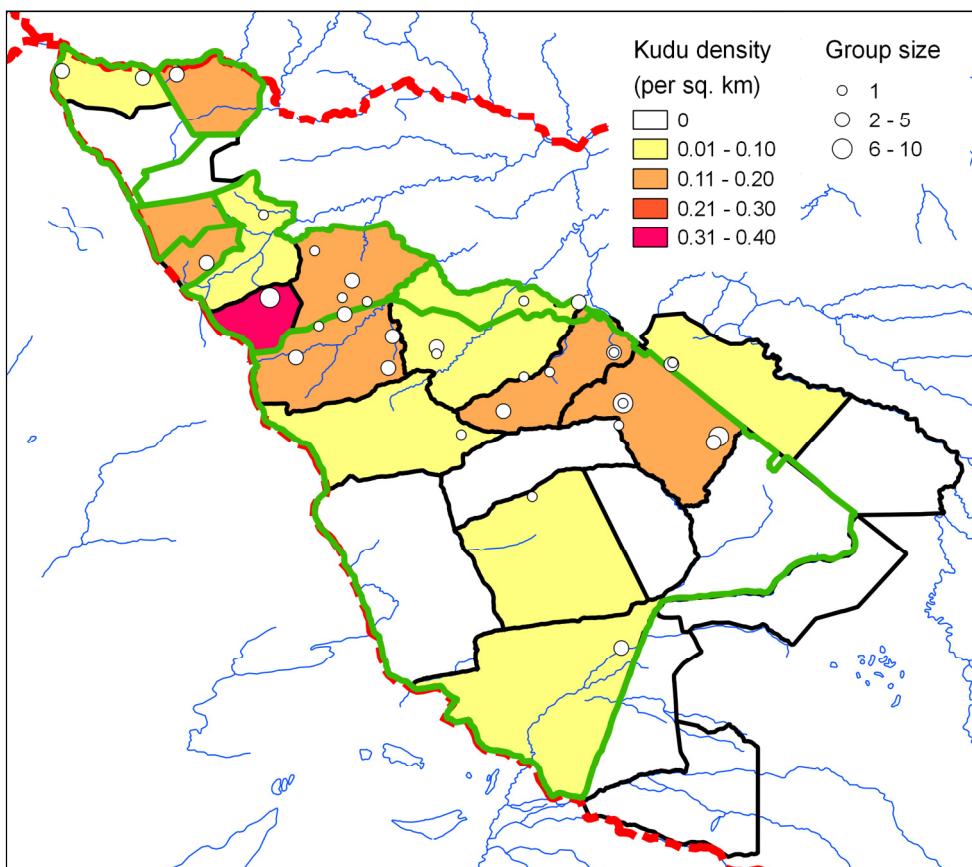
Table 18. Population estimates and statistics for Zebra in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	260	15	53315	228.4	15	854	0.47
Kazungula	33	3	1058	226.3	3	106	0.07
Panda Masuie	117	5	9438	196.9	5	346	0.12
Kazuma	0	0	0	0.0	0	0	0
Matetsi	363	11	29074	149.6	11	905	0.52
Rosslyn	851	53	689983	310.4	53	3495	2.44
Zanguja	466	21	44373	116.3	21	1007	0.55
Subtotals	2089	108	827242	120.9	108	4614	0.48
Hwange NP							
Robins	784	72	114199	96.1	72	1536	0.77
Dandari	57	7	2835	190.6	7	166	0.04
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	400	30	72092	144.1	30	976	0.19
Sinamatella	174	17	5566	90.4	17	331	0.12
Mtoa	70	8	4733	204.3	8	214	0.09
Main Camp	241	21	33060	162.6	21	634	0.19
Shapi	36	5	1137	193.6	5	105	0.04
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	302	27	26101	113.3	27	645	0.19
Subtotals	2065	187	259723	50.0	1032	3097	0.14
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	4154	295	1086965	59.4	1688	6619	0.17

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Map 15. Distribution of giraffe in north-west Matabeleland during October 2014



Map 16. Distribution of kudu in north-west Matabeleland during October 2014

Table 19. Population estimates and statistics for Giraffe in north-west Matabeleland

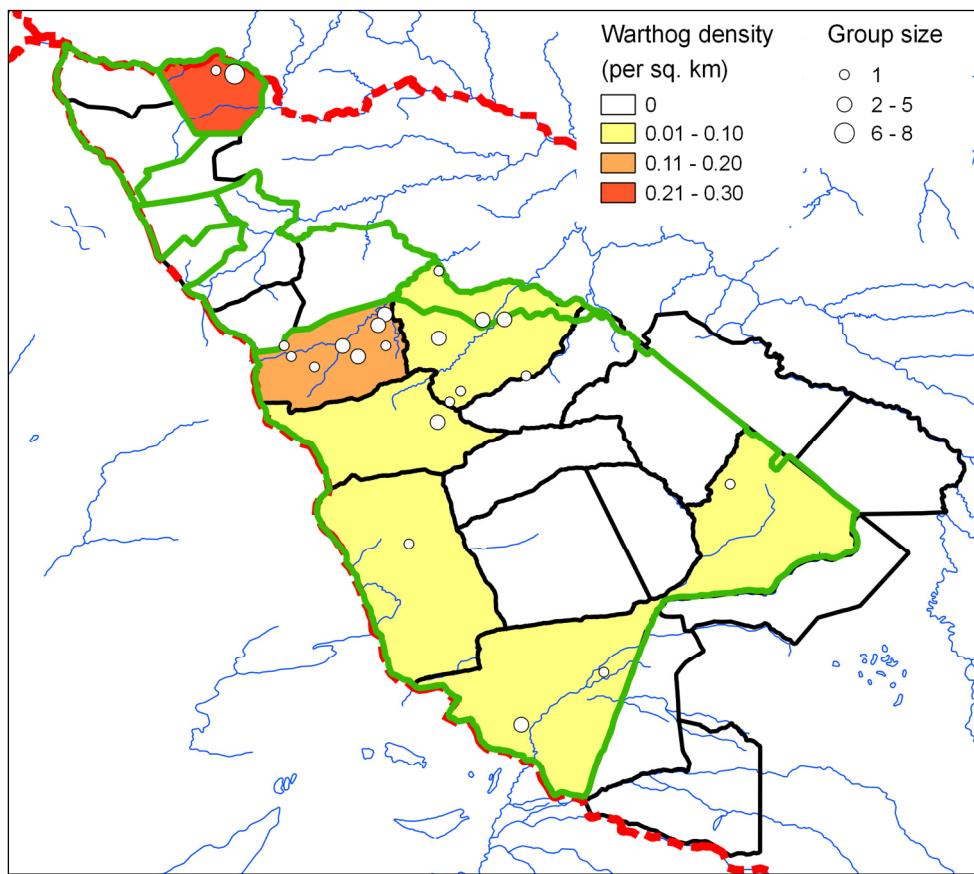
Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	35	2	975	231.6	2	115	0.06
Kazungula	33	3	1058	226.3	3	106	0.07
Panda Masuie	187	8	10127	127.5	8	425	0.2
Kazuma	25	1	560	305.4	1	100	0.04
Matetsi	33	1	1030	309.8	1	135	0.05
Rosslyn	16	1	402	397.2	1	80	0.05
Zanguja	22	1	343	214.7	1	70	0.03
Subtotals	350	17	14496	74.4	90	610	0.08
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	49	6	619	103.9	6	100	0.04
Shakwanki	132	9	3454	95.1	9	259	0.06
Dzivanini	360	27	65534	152.6	27	909	0.17
Sinamatella	61	6	1096	113.7	6	131	0.04
Mtoa	97	11	1908	94.4	11	188	0.12
Main Camp	207	18	13405	120.8	18	457	0.17
Shapi	86	12	5498	177.4	12	239	0.09
Central B	61	4	1582	150.6	4	153	0.04
Central A	14	1	204	224.2	1	47	0.02
Ngamo	90	8	1885	102.8	8	182	0.05
Subtotals	1158	102	95185	54.6	526	1790	0.08
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	33	2	1156	241.0	2	114	0.03
Sikumi Forest	27	1	812	255.6	1	97	0.02
Subtotals	61	3	1968	159.4	3	157	0.03
Totals	1568	122	111650	43.2	890	2246	0.06

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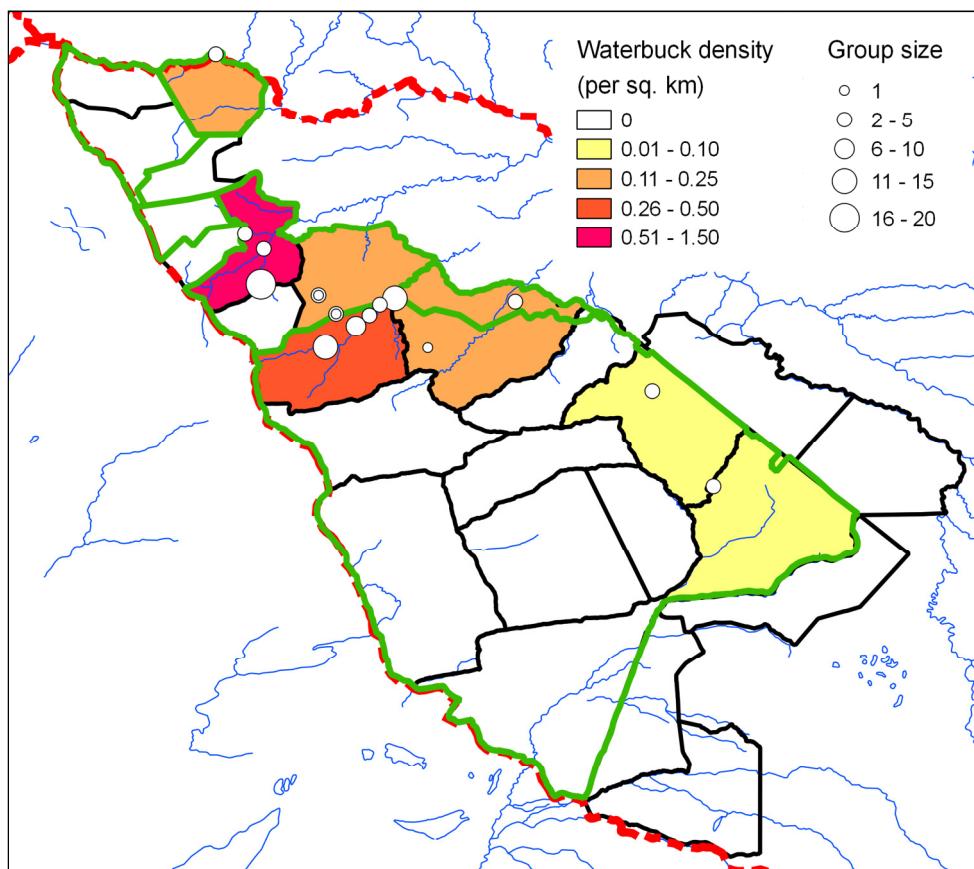
Table 20. Population estimates and statistics for Kudu in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	69	4	4922	260.3	4	250	0.13
Kazungula	43	4	849	152.0	4	109	0.1
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	99	4	8962	305.4	4	400	0.18
Matetsi	33	1	1030	309.8	1	135	0.05
Rosslyn	129	8	21865	366.1	8	599	0.37
Zanguja	111	5	2731	121.2	5	245	0.13
Subtotals	484	26	40360	95.8	26	947	0.11
Hwange NP							
Robins	120	11	1596	74.4	31	209	0.12
Dandari	8	1	60	193.5	1	24	0.006
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	53	4	2772	211.9	4	166	0.03
Sinamatella	102	10	2861	110.2	10	215	0.07
Mtoa	88	10	2750	124.6	10	198	0.11
Main Camp	230	20	22245	140.1	20	552	0.18
Shapi	0	0	0	0.0	0	0	0
Central B	15	1	228	228.6	1	50	0.01
Central A	0	0	0	0.0	0	0	0
Ngamo	0	0	0	0.0	0	0	0
Subtotals	617	57	32513	60.1	246	988	0.04
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	82	3	7310	255.6	3	291	0.07
Subtotals	82	3	7310	255.6	3	291	0.04
Totals	1182	86	80182	49.2	600	1764	0.05

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Map 17. Distribution of warthog in north-west Matabeleland during October 2014



Map 18. Distribution of waterbuck in north-west Matabeleland during October 2014

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Table 21. Population estimates and statistics for Warthog in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	121	7	8336	193.6	7	356	0.22
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	121	7	8336	193.5	7	356	0.03
Hwange NP							
Robins	207	19	6796	88.8	23	390	0.2
Dandari	16	2	231	190.3	2	47	0.01
Shakwanki	15	1	192	202.0	1	44	0.007
Dzivanini	53	4	1670	164.5	4	141	0.03
Sinamatella	123	12	1948	75.8	30	216	0.08
Mtoa	0	0	0	0.0	0	0	0
Main Camp	0	0	0	0.0	0	0	0
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	11	1	100	189.0	1	32	0.007
Subtotals	425	39	10938	50.9	209	642	0.03
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	546	46	19274	53.2	256	837	0.02

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Table 22. Population estimates and statistics for Wildebeest in north-west Matabeleland

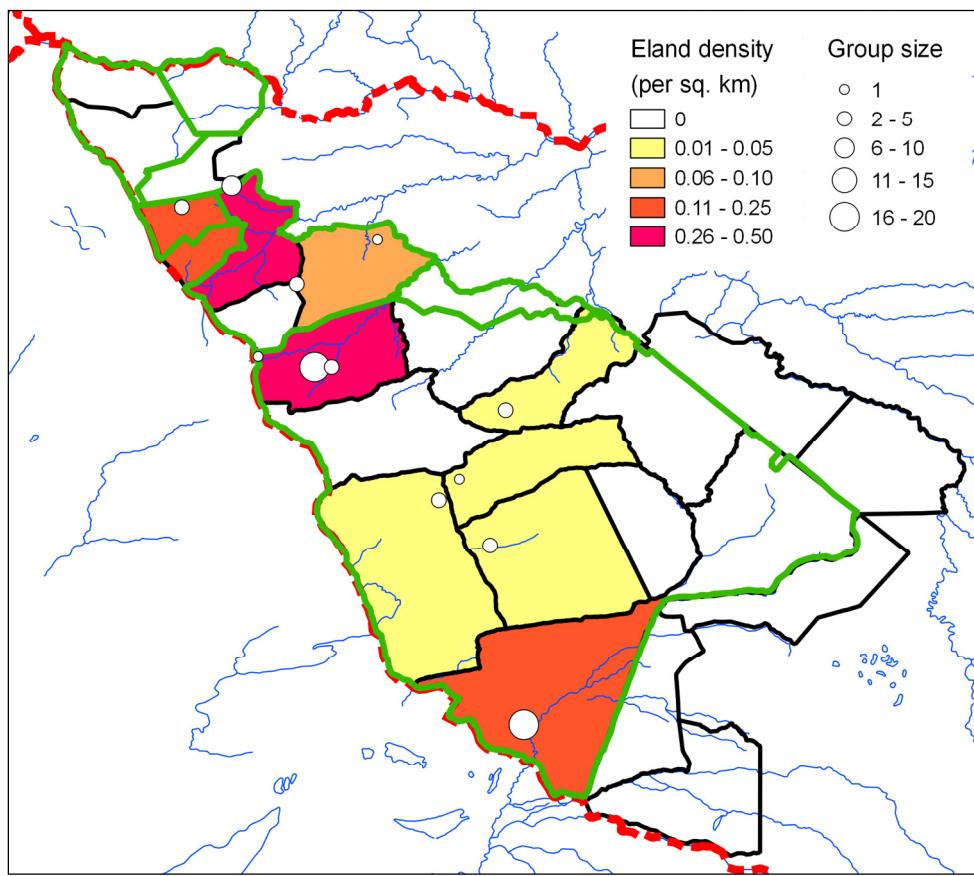
Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	0	0	0	0.0	0	0	0
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	0	0	0	0.0	0	0	0
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	0	0	0	0.0	0	0	0
Main Camp	0	0	0	0.0	0	0	0
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	818	30	656721	242.3	30	2801	0.71
Subtotals	818	30	656721	242.3	30	2801	0.35
Totals	818	30	656721	242.3	30	2801	0.03

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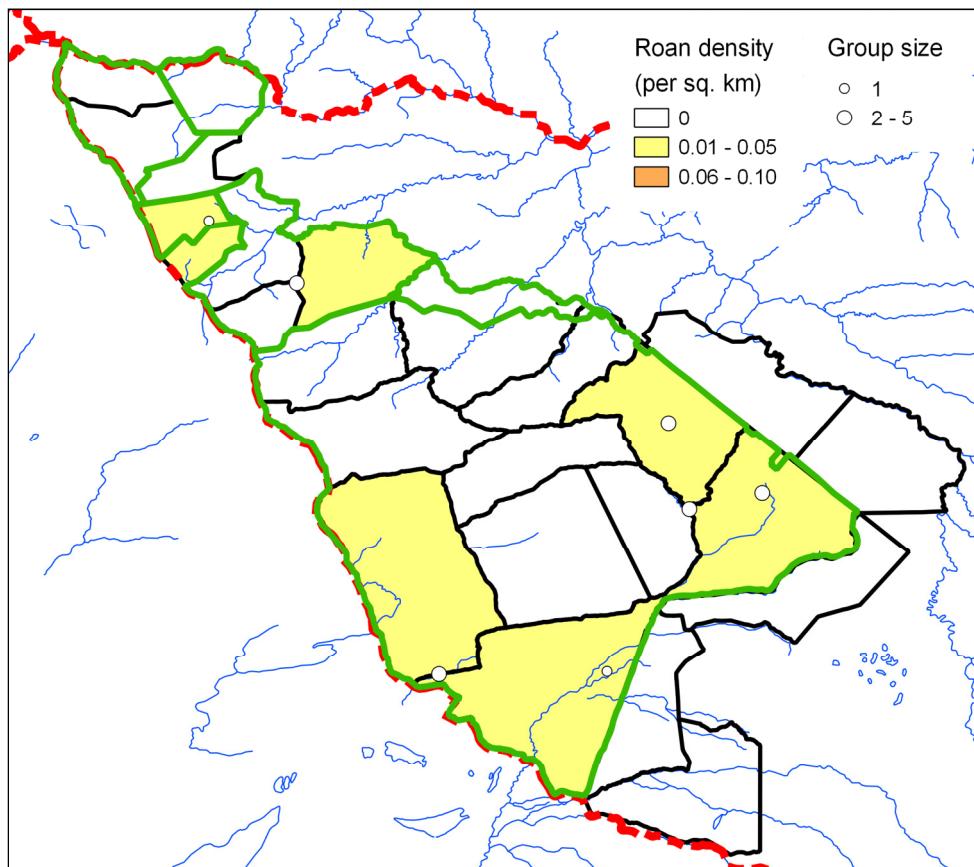
Table 23. Population estimates and statistics for Waterbuck in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	69	4	3791	228.4	4	228	0.13
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	923	28	416897	222.5	28	2978	1.32
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	200	9	9785	127.4	9	454	0.24
Subtotals	1192	41	430473	175.1	41	3280	0.27
Hwange NP							
Robins	294	27	21948	112.3	27	624	0.29
Dandari	0	0	0	0.0	0	0	0
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	0	0	0	0.0	0	0	0
Sinamatella	174	17	17720	161.4	17	455	0.12
Mtoa	0	0	0	0.0	0	0	0
Main Camp	46	4	2155	218.0	4	146	0.04
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	22	2	408	191.3	2	65	0.01
Subtotals	536	50	42232	78.8	114	959	0.04
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	1728	91	472705	126.6	91	3917	0.07

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Map 19. Distribution of eland in north-west Matabeleland during October 2014



Map 20. Distribution of roan in north-west Matabeleland during October 2014

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Table 24. Population estimates and statistics for Eland in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	123	5	12644	290.2	5	481	0.22
Matetsi	264	8	65945	309.8	8	1081	0.38
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	89	4	4139	186.4	4	254	0.1
Subtotals	476	17	82728	167.8	17	1274	0.11
Hwange NP							
Robins	261	24	48995	188.8	24	754	0.26
Dandari	0	0	0	0.0	0	0	0
Shakwanki	29	2	762	201.1	2	89	0.01
Dzivanini	266	20	71452	215.2	20	840	0.13
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	44	5	1736	198.0	5	131	0.05
Main Camp	0	0	0	0.0	0	0	0
Shapi	7	1	45	193.2	1	21	0.008
Central B	30	2	942	232.4	2	101	0.02
Central A	0	0	0	0.0	0	0	0
Ngamo	0	0	0	0.0	0	0	0
Subtotals	639	54	123934	113.5	54	1364	0.04
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	1115	71	206662	85.1	166	2063	0.04

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Table 25. Population estimates and statistics for Roan in north-west Matabeleland

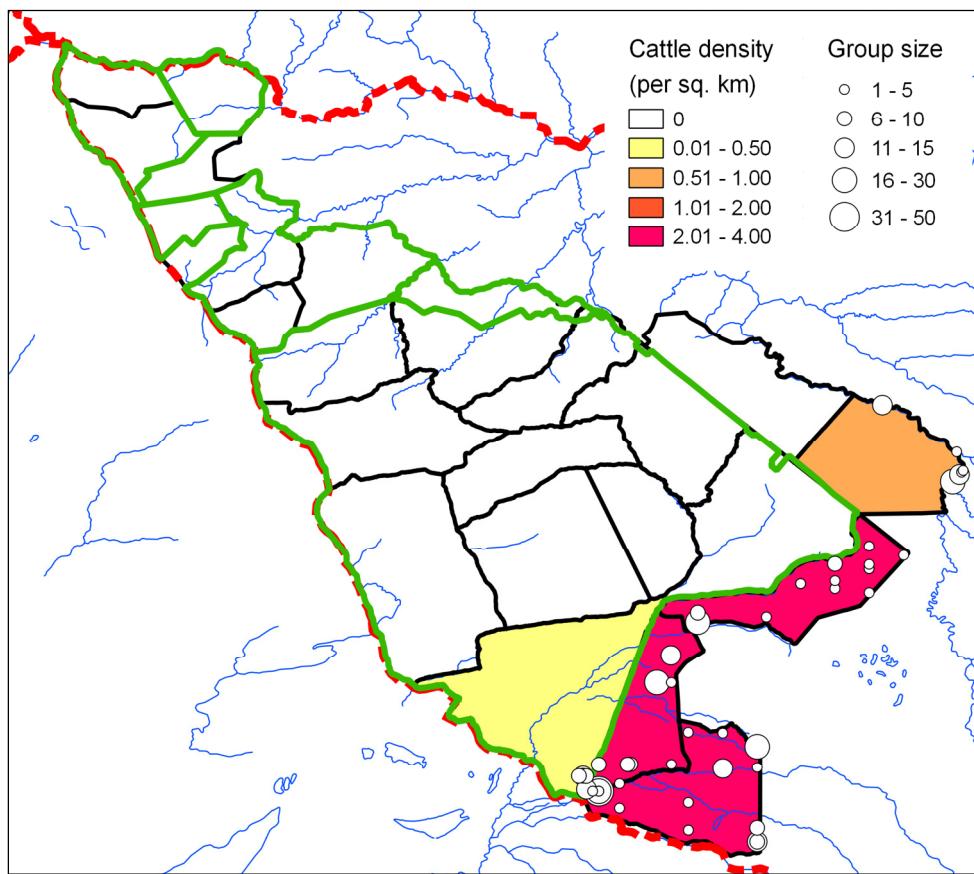
Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	25	1	560	305.4	1	100	0.04
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	44	2	1964	256.8	2	158	0.05
Subtotals	69	3	2524	172.1	3	188	0.02
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	0	0	0	0.0	0	0	0
Shakwanki	29	2	847	212.0	2	92	0.01
Dzivanini	13	1	171	210.7	1	41	0.006
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	0	0	0	0.0	0	0	0
Main Camp	46	4	2110	215.7	4	145	0.04
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	56	5	1168	129.5	5	128	0.03
Subtotals	145	12	4296	91.7	12	277	0.01
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	214	15	6820	78.5	46	382	0.01

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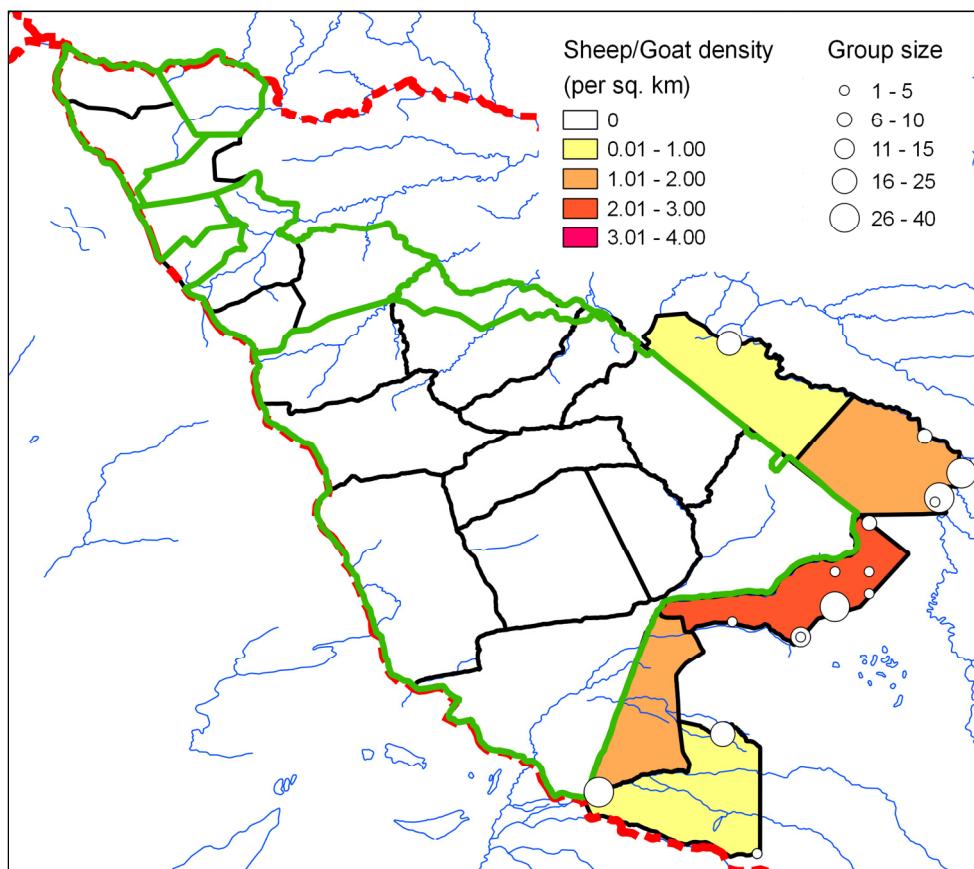
Table 26. Population estimates and statistics for Gemsbok in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	8	1	59	191.8	1	24	0.006
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	0	0	0	0.0	0	0	0
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	0	0	0	0.0	0	0	0
Main Camp	0	0	0	0.0	0	0	0
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	0	0	0	0.0	0	0	0
Subtotals	8	1	59	191.9	1	24	0.001
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	8	1	59	191.9	1	24	0.0003

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Map 21. Distribution of cattle in north-west Matabeleland during October 2014



Map 22. Distribution of sheep and goats in north-west Matabeleland during October 2014

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Table 27. Population estimates and statistics for Cattle in north-west Matabeleland

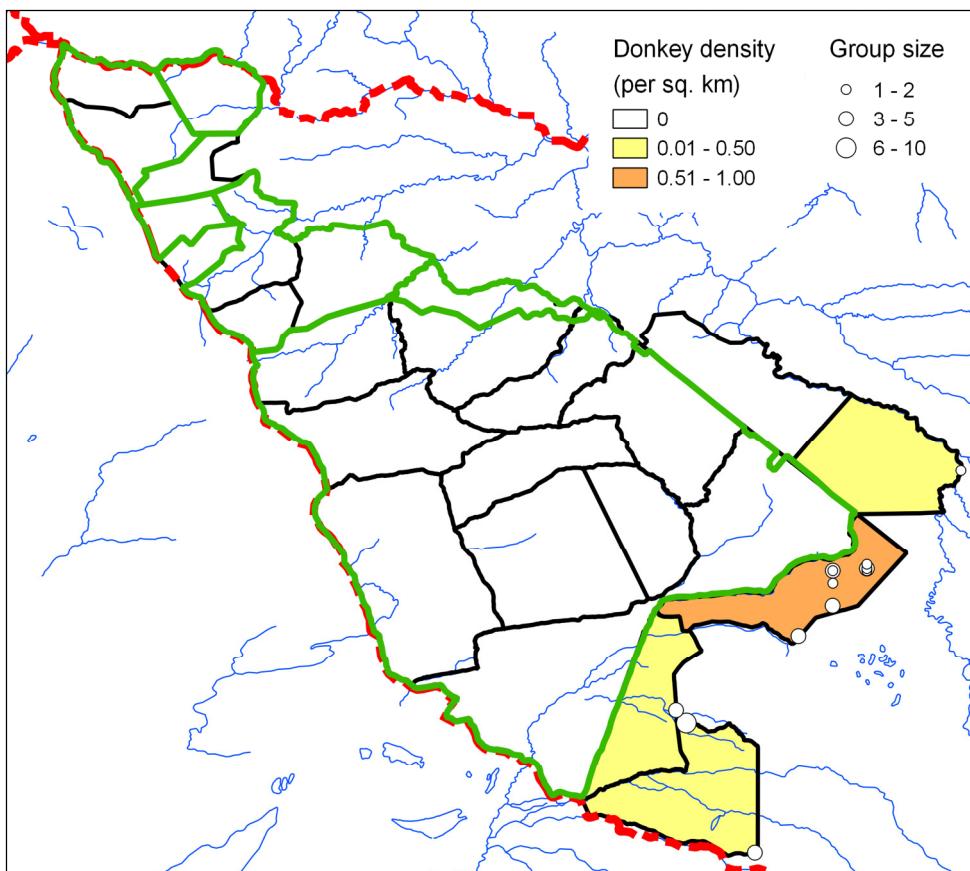
Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	0	0	0	0.0	0	0	0
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	733	55	369846	178.0	55	2037	0.35
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	0	0	0	0.0	0	0	0
Main Camp	0	0	0	0.0	0	0	0
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	0	0	0	0.0	0	0	0
Subtotals	733	55	369846	178.0	55	2037	0.05
Communal Areas							
Tsholotsho East	3629	136	5400148	156.7	136	9315	3.97
Maitengwe	2581	88	1269404	112.2	88	5478	2.15
Tsholotsho North	2550	75	745095	80.0	509	4592	2.66
Subtotals	8760	299	7414648	69.3	2693	14827	2.85
Forest Areas							
Ngamo Forest	1001	60	645137	189.8	60	2901	0.85
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	1001	60	645137	189.7	60	2900	0.43
Totals	10494	414	8429631	59.8	4222	16766	0.42

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Table 28. Population estimates and statistics for Sheep and Goats in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	0	0	0	0.0	0	0	0
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	0	0	0	0.0	0	0	0
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	0	0	0	0.0	0	0	0
Main Camp	0	0	0	0.0	0	0	0
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Communal Areas							
Tsholotsho East	1067	40	1453045	276.4	40	4017	1.17
Maitengwe	675	23	213999	176.3	23	1864	0.56
Tsholotsho North	2584	76	1031315	92.9	183	4986	2.7
Subtotals	4326	139	2698359	81.4	803	7849	1.41
Forest Areas							
Ngamo Forest	1218	73	1373560	227.6	73	3990	1.04
Sikumi Forest	682	25	504496	254.8	25	2420	0.59
Subtotals	1900	98	1878056	158.8	98	4916	0.81
Totals	6226	237	4576414	70.8	1820	10632	0.25

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Map 23. Distribution of donkeys in north-west Matabeleland during October 2014

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Table 29. Population estimates and statistics for Donkeys in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hwange NP							
Robins	0	0	0	0.0	0	0	0
Dandari	0	0	0	0.0	0	0	0
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	0	0	0	0.0	0	0	0
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	0	0	0	0.0	0	0	0
Main Camp	0	0	0	0.0	0	0	0
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Communal Areas							
Tsholotsho East	107	4	11163	242.2	4	365	0.12
Maitengwe	381	13	59271	164.2	13	1007	0.32
Tsholotsho North	714	21	61901	82.4	126	1303	0.75
Subtotals	1202	38	132335	65.4	416	1988	0.39
Forest Areas							
Ngamo Forest	17	1	347	264.0	1	61	0.01
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	17	1	347	263.9	1	61	0.01
Totals	1219	39	132682	64.6	432	2006	0.05

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Table 30. Population estimates and statistics for Ostrich in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	23	1	430	210.1	1	72	0.02
Kazuma	0	0	0	0.0	0	0	0
Matetsi	0	0	0	0.0	0	0	0
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	0	0	0	0.0	0	0	0
Subtotals	23	1	430	210.1	1	72	0.01
Hwange NP							
Robins	54	5	2489	204.3	5	166	0.05
Dandari	0	0	0	0.0	0	0	0
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	0	0	0	0.0	0	0	0
Sinamatella	0	0	0	0.0	0	0	0
Mtoa	0	0	0	0.0	0	0	0
Main Camp	0	0	0	0.0	0	0	0
Shapi	7	1	46	194.6	1	21	0.008
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	0	0	0	0.0	0	0	0
Subtotals	62	6	2535	182.1	6	174	0.004
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	85	7	2965	138.5	7	203	0.003

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Table 31. Population estimates and statistics for Ground Hornbill in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	%CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0
Kazungula	0	0	0	0.0	0	0	0
Panda Masuie	0	0	0	0.0	0	0	0
Kazuma	0	0	0	0.0	0	0	0
Matetsi	165	5	34753	359.8	5	758	0.24
Rosslyn	0	0	0	0.0	0	0	0
Zanguja	89	4	7297	247.5	4	308	0.1
Subtotals	254	9	42050	224.5	9	823	0.06
Hwange NP							
Robins	33	3	905	205.3	3	100	0.03
Dandari	0	0	0	0.0	0	0	0
Shakwanki	0	0	0	0.0	0	0	0
Dzivanini	93	7	3822	142.2	7	226	0.04
Sinamatella	51	5	1097	136.5	5	121	0.03
Mtoa	0	0	0	0.0	0	0	0
Main Camp	57	5	1610	150.7	5	144	0.05
Shapi	0	0	0	0.0	0	0	0
Central B	0	0	0	0.0	0	0	0
Central A	0	0	0	0.0	0	0	0
Ngamo	0	0	0	0.0	0	0	0
Subtotals	235	20	7434	74.3	60	409	0.02
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0
Maitengwe	0	0	0	0.0	0	0	0
Tsholotsho North	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	488	29	49484	117.1	29	1060	0.02

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Appendix 1. Calibration of strip width

For each run (i.e. flight over the calibration numbers):

- Strip width (in meters) for one observer = $10 \times (1 + \text{Difference between outer and inner})$;
- Combined strip width (in meters) at flying height = Left strip width + right strip width; and
- Combined strip width at 300 ft agl¹ = Actual combined strip width x 300 / (Flying height)

¹ agl: above ground level

Calibration flights were flown at Main Camp on 6 October 2014 (runs 1-25), 9 October (runs 26-29), and 15 October (runs 30-34).

Run no.	Left observer: Colum Zhuwau			Right observer: Greg Nyaguse			Combined strip width (m) at flying height	Flying height agl (ft)	Combined strip width (m) when flying at 300 ft
	Outer marker	Inner marker	Strip width (m)	Outer marker	Inner marker	Strip width (m)			
1	24	8	170	20	6	150	320	310	310
2	22	7	160	21	8	140	300	295	305
3	20	5	160	21	8	140	300	305	295
4	19	6	140	21	8	140	280	319	263
5	20	7	140	23	9	150	290	300	290
6	18	6	130	29	11	190	320	328	293
7	16	5	120	17	7	110	230	254	272
8	19	7	130	18	6	130	260	256	305
9	16	5	120	18	6	130	250	249	301
10	19	5	150	20	7	140	290	264	330
11	17	4	140	19	6	140	280	242	347
12	16	5	120	19	7	130	250	251	299
13	24	6	190	27	10	180	370	340	326
14	27	8	200	24	8	170	370	347	320
15	23	4	200	23	7	170	370	347	320
16	23	8	160	28	8	210	370	366	303
17	27	10	180	25	9	170	350	352	298
18	22	8	150	26	10	170	320	328	293
19	19	7	130	21	8	140	270	284	285
20	22	8	150	22	9	140	290	300	290
21	20	6	150				-	301	-
22	20	7	140	21	9	130	270	299	271
23	17	7	110	23	8	160	270	287	282
24	20	6	150	19	7	130	280	281	299
25	18	5	140	25	8	180	320	283	339
26	17	5	130	22	8	150	280	283	297
27	21	7	150	23	8	160	310	315	295
28	26	8	190	21	8	140	330	354	280
29	17	7	110	17	6	120	230	247	279
30	23	7	170	21	8	140	310	302	308
31	18	7	120	25	9	170	290	306	284
32	24	9	160	26	10	170	330	349	284
33	21	6	160	29	10	200	360	347	311
34	18	8	110	17	5	130	240	255	282
Mean combined strip width (in meters) when flying at 300 feet agl =									299
Standard error of mean combined strip width as a percentage of the mean									1.1

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Appendix 2. Survey flight summary

Date	Time take off	Time land	Flight time (hours)	Duty
05-Oct-14			1.70	Positioning, Harare to Main Camp
06-Oct-14	15:03	16:58	1.92	Calibration
07-Oct-14	6:56	8:42	1.77	Aborted flight
07-Oct-14	14:37	16:41	2.07	Stratum Kazuma
08-Oct-14	7:06	10:46	3.67	Strata Kazungula & Zambezi NP
08-Oct-14	14:51	16:43	1.87	Stratum Matetsi
09-Oct-14	7:09	10:09	3.00	Stratum Panda Masuie
09-Oct-14	15:07	16:50	1.72	Stratum Rosslyn
10-Oct-14	7:04	10:30	3.43	Stratum Robins
11-Oct-14			2.00	Main Camp to Charles Prince
11-Oct-14			2.00	Charles Prince to Main Camp
12-Oct-14	6:53	10:54	4.02	Stratum Sinamatella
12-Oct-14	14:50	17:02	2.20	Stratum Zanguja
13-Oct-14	6:53	9:52	2.98	Stratum Main Camp
13-Oct-14	14:20	17:18	2.97	Stratum Mtoa
15-Oct-14	6:26	10:31	4.08	Stratum Dandari, transects 1-20
15-Oct-14	14:54	16:54	2.00	Stratum Central A
16-Oct-14	6:24	11:04	4.67	Stratum Shapi & stratum Dandari transects 21-29
16-Oct-14	14:53	16:37	1.73	Stratum Sikumi Forest
17-Oct-14	6:24	10:52	4.47	Stratum Shakwanki
17-Oct-14	14:36	16:55	2.32	Stratum Ngamo Forest
18-Oct-14	6:22	11:10	4.80	Stratum Dzivanini
18-Oct-14	14:37	16:48	2.18	Stratum Tsholotsho East
20-Oct-14	6:19		2.20	Main Camp to Charles Prince
21-Oct-14			1.80	Charles Prince to Main Camp
21-Oct-14	14:37	16:58	2.35	Stratum Maitengwe
22-Oct-14	7:19	11:00	3.68	Stratum Ngamo
22-Oct-14	15:01	17:03	2.03	Stratum Tsholotsho North
23-Oct-14	7:16	10:34	3.30	Stratum Central B
23-Oct-14	12:30		2.00	Main Camp to Charles Prince
Total			80.92	

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Appendix 3. Transect start and end points, and lengths

Degrees and decimal minutes; datum WGS84

Central A

Number of transects : 10

Transect Bearing : 66.00 Degrees

Transect Spacing : 4.40 km

Transect # : 1

Start Lat : S 18 : 57.739 Start Lon : E 26 : 48.023
Finish Lat : S 18 : 59.851 Finish Lon : E 26 : 43.008
Length : 9.62 km

Transect # : 2

Start Lat : S 19 : 2.001 Start Lon : E 26 : 44.081
Finish Lat : S 18 : 58.614 Finish Lon : E 26 : 52.123
Length : 15.42 km

Transect # : 3

Start Lat : S 19 : 0.120 Start Lon : E 26 : 54.721
Finish Lat : S 19 : 4.150 Finish Lon : E 26 : 45.153
Length : 18.35 km

Transect # : 4

Start Lat : S 19 : 6.299 Start Lon : E 26 : 46.226
Finish Lat : S 19 : 2.063 Finish Lon : E 26 : 56.285
Length : 19.29 km

Transect # : 5

Start Lat : S 19 : 3.929 Start Lon : E 26 : 58.029
Finish Lat : S 19 : 8.448 Finish Lon : E 26 : 47.298
Length : 20.58 km

Transect # : 6

Start Lat : S 19 : 10.597 Start Lon : E 26 : 48.371
Finish Lat : S 19 : 5.891 Finish Lon : E 26 : 59.545
Length : 21.43 km

Transect # : 7

Start Lat : S 19 : 8.230 Start Lon : E 27 : 0.167
Finish Lat : S 19 : 12.747 Finish Lon : E 26 : 49.443
Length : 20.56 km

Transect # : 8

Start Lat : S 19 : 14.896 Start Lon : E 26 : 50.516
Finish Lat : S 19 : 10.624 Finish Lon : E 27 : 0.660
Length : 19.45 km

Transect # : 9

Start Lat : S 19 : 12.883 Start Lon : E 27 : 1.470
Finish Lat : S 19 : 17.045 Finish Lon : E 26 : 51.588
Length : 18.95 km

Transect # : 10

Start Lat : S 19 : 19.194 Start Lon : E 26 : 52.660
Finish Lat : S 19 : 16.411 Finish Lon : E 26 : 59.268
Length : 12.67 km

Central B

Number of transects : 9

Transect Bearing : -26.00 Degrees

Transect Spacing : 4.60 km

Transect # : 1

Start Lat : S 18 : 58.423 Start Lon : E 26 : 40.271
Finish Lat : S 19 : 20.656 Finish Lon : E 26 : 51.731
Length : 45.81 km

Transect # : 2

Start Lat : S 19 : 22.423 Start Lon : E 26 : 49.721
Finish Lat : S 18 : 59.062 Finish Lon : E 26 : 37.679
Length : 48.13 km

Transect # : 3

Start Lat : S 19 : 0.589 Start Lon : E 26 : 35.545
Finish Lat : S 19 : 22.875 Finish Lon : E 26 : 47.033
Length : 45.92 km

Transect # : 4

Start Lat : S 19 : 23.148 Start Lon : E 26 : 44.253
Finish Lat : S 19 : 2.155 Finish Lon : E 26 : 33.432
Length : 43.25 km

Transect # : 5

Start Lat : S 19 : 2.958 Start Lon : E 26 : 30.925

Finish Lat : S 19 : 23.698 Finish Lon : E 26 : 41.616
Length : 42.73 km

Transect # : 6

Start Lat : S 19 : 23.785 Start Lon : E 26 : 38.740
Finish Lat : S 19 : 3.842 Finish Lon : E 26 : 28.459
Length : 41.09 km

Transect # : 7

Start Lat : S 19 : 5.681 Start Lon : E 26 : 26.487
Finish Lat : S 19 : 24.151 Finish Lon : E 26 : 36.007
Length : 38.05 km

Transect # : 8

Start Lat : S 19 : 24.542 Start Lon : E 26 : 33.288
Finish Lat : S 19 : 6.609 Finish Lon : E 26 : 24.044
Length : 36.95 km

Transect # : 9

Start Lat : S 19 : 8.043 Start Lon : E 26 : 21.862

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Finish Lat : S 19 : 24.861 Finish Lon : E 26 : 30.532
Length : 34.65 km

Dandari

Number of transects : 29
Transect Bearing : 0.00 Degrees
Transect Spacing : 2.50 km

Transect # : 1
Start Lat : S 18 : 48.994 Start Lon : E 25 : 49.255
Finish Lat : S 18 : 47.393 Finish Lon : E 25 : 49.255
Length : 2.96 km

Transect # : 2
Start Lat : S 18 : 47.382 Start Lon : E 25 : 50.679
Finish Lat : S 18 : 50.828 Finish Lon : E 25 : 50.679
Length : 6.38 km

Transect # : 3
Start Lat : S 18 : 51.537 Start Lon : E 25 : 52.102
Finish Lat : S 18 : 47.354 Finish Lon : E 25 : 52.102
Length : 7.75 km

Transect # : 4
Start Lat : S 18 : 49.039 Start Lon : E 25 : 53.525
Finish Lat : S 18 : 52.607 Finish Lon : E 25 : 53.525
Length : 6.61 km

Transect # : 5
Start Lat : S 18 : 53.583 Start Lon : E 25 : 54.948
Finish Lat : S 18 : 48.584 Finish Lon : E 25 : 54.948
Length : 9.26 km

Transect # : 6
Start Lat : S 18 : 48.487 Start Lon : E 25 : 56.372
Finish Lat : S 18 : 54.077 Finish Lon : E 25 : 56.372
Length : 10.35 km

Transect # : 7
Start Lat : S 18 : 56.083 Start Lon : E 25 : 57.795
Finish Lat : S 18 : 48.258 Finish Lon : E 25 : 57.795
Length : 14.49 km

Transect # : 8
Start Lat : S 18 : 47.411 Start Lon : E 25 : 59.218
Finish Lat : S 18 : 59.394 Finish Lon : E 25 : 59.218
Length : 22.19 km

Transect # : 9
Start Lat : S 19 : 1.563 Start Lon : E 26 : 0.642
Finish Lat : S 18 : 47.214 Finish Lon : E 26 : 0.642
Length : 26.57 km

Transect # : 10
Start Lat : S 18 : 46.983 Start Lon : E 26 : 2.065
Finish Lat : S 19 : 0.940 Finish Lon : E 26 : 2.065
Length : 25.85 km

Transect # : 11
Start Lat : S 18 : 59.566 Start Lon : E 26 : 3.488
Finish Lat : S 18 : 46.631 Finish Lon : E 26 : 3.488
Length : 23.95 km

Transect # : 12

Start Lat : S 18 : 46.674 Start Lon : E 26 : 4.911
Finish Lat : S 19 : 0.330 Finish Lon : E 26 : 4.911
Length : 25.29 km

Transect # : 13
Start Lat : S 19 : 0.144 Start Lon : E 26 : 6.335
Finish Lat : S 18 : 46.087 Finish Lon : E 26 : 6.335
Length : 26.03 km

Transect # : 14
Start Lat : S 18 : 44.793 Start Lon : E 26 : 7.758
Finish Lat : S 18 : 59.801 Finish Lon : E 26 : 7.758
Length : 27.79 km

Transect # : 15
Start Lat : S 18 : 59.652 Start Lon : E 26 : 9.181
Finish Lat : S 18 : 44.190 Finish Lon : E 26 : 9.181
Length : 28.63 km

Transect # : 16
Start Lat : S 18 : 43.773 Start Lon : E 26 : 10.604
Finish Lat : S 18 : 59.544 Finish Lon : E 26 : 10.604
Length : 29.21 km

Transect # : 17
Start Lat : S 18 : 59.124 Start Lon : E 26 : 12.028
Finish Lat : S 18 : 43.343 Finish Lon : E 26 : 12.028
Length : 29.22 km

Transect # : 18
Start Lat : S 18 : 42.500 Start Lon : E 26 : 13.451
Finish Lat : S 18 : 58.951 Finish Lon : E 26 : 13.451
Length : 30.46 km

Transect # : 19
Start Lat : S 18 : 58.737 Start Lon : E 26 : 14.874
Finish Lat : S 18 : 41.777 Finish Lon : E 26 : 14.874
Length : 31.41 km

Transect # : 20A
Start Lat : S 18 : 41.939 Start Lon : E 26 : 16.298
Finish Lat : S 18 : 44.893 Finish Lon : E 26 : 16.298
Length : 5.47 km

Transect # : 20B
Start Lat : S 18 : 45.043 Start Lon : E 26 : 16.298
Finish Lat : S 18 : 59.045 Finish Lon : E 26 : 16.298
Length : 25.93 km

Transect # : 21
Start Lat : S 18 : 59.356 Start Lon : E 26 : 17.721
Finish Lat : S 18 : 47.049 Finish Lon : E 26 : 17.721
Length : 22.79 km

Transect # : 22

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Start Lat : S 18 : 47.639 Start Lon : E 26 : 19.144
 Finish Lat : S 18 : 59.157 Finish Lon : E 26 : 19.144
 Length : 21.33 km

Transect # : 23
 Start Lat : S 18 : 58.360 Start Lon : E 26 : 20.567
 Finish Lat : S 18 : 48.383 Finish Lon : E 26 : 20.567
 Length : 18.48 km

Transect # : 24
 Start Lat : S 18 : 50.394 Start Lon : E 26 : 21.991
 Finish Lat : S 18 : 58.051 Finish Lon : E 26 : 21.991
 Length : 14.18 km

Transect # : 25
 Start Lat : S 18 : 55.649 Start Lon : E 26 : 23.414
 Finish Lat : S 18 : 50.968 Finish Lon : E 26 : 23.414
 Length : 8.67 km

Transect # : 26
 Start Lat : S 18 : 51.571 Start Lon : E 26 : 24.837
 Finish Lat : S 18 : 54.747 Finish Lon : E 26 : 24.837
 Length : 5.88 km

Transect # : 27
 Start Lat : S 18 : 53.854 Start Lon : E 26 : 26.260
 Finish Lat : S 18 : 52.027 Finish Lon : E 26 : 26.260
 Length : 3.38 km

Transect # : 28
 Start Lat : S 18 : 52.081 Start Lon : E 26 : 27.684
 Finish Lat : S 18 : 53.358 Finish Lon : E 26 : 27.684
 Length : 2.37 km

Transect # : 29
 Start Lat : S 18 : 52.560 Start Lon : E 26 : 29.107
 Finish Lat : S 18 : 52.189 Finish Lon : E 26 : 29.107
 Length : 0.69 km

Dzivanini

Number of transects : 15

Transect Bearing : 90.00 Degrees

Transect Spacing : 4.00 km

Transect # : 1
 Start Lat : S 19 : 21.669 Start Lon : E 26 : 54.858
 Finish Lat : S 19 : 21.669 Finish Lon : E 26 : 50.208
 Length : 8.13 km

Transect # : 2
 Start Lat : S 19 : 23.829 Start Lon : E 26 : 38.414
 Finish Lat : S 19 : 23.829 Finish Lon : E 26 : 53.325
 Length : 26.08 km

Transect # : 3
 Start Lat : S 19 : 25.989 Start Lon : E 26 : 52.256
 Finish Lat : S 19 : 25.989 Finish Lon : E 26 : 25.444
 Length : 46.89 km

Transect # : 4
 Start Lat : S 19 : 28.149 Start Lon : E 26 : 24.340
 Finish Lat : S 19 : 28.149 Finish Lon : E 26 : 51.475
 Length : 47.45 km

Transect # : 5
 Start Lat : S 19 : 30.309 Start Lon : E 26 : 50.694
 Finish Lat : S 19 : 30.309 Finish Lon : E 26 : 24.455
 Length : 45.89 km

Transect # : 6
 Start Lat : S 19 : 32.469 Start Lon : E 26 : 21.005
 Finish Lat : S 19 : 32.469 Finish Lon : E 26 : 49.913
 Length : 50.55 km

Transect # : 7A
 Start Lat : S 19 : 34.629 Start Lon : E 26 : 49.129
 Finish Lat : S 19 : 34.629 Finish Lon : E 26 : 18.782
 Length : 53.07 km

Transect # : 7B

Start Lat : S 19 : 34.629 Start Lon : E 26 : 18.063
 Finish Lat : S 19 : 34.629 Finish Lon : E 26 : 14.093
 Length : 6.94 km

Transect # : 8
 Start Lat : S 19 : 36.789 Start Lon : E 26 : 21.439
 Finish Lat : S 19 : 36.789 Finish Lon : E 26 : 48.341
 Length : 47.05 km

Transect # : 9
 Start Lat : S 19 : 38.949 Start Lon : E 26 : 47.552
 Finish Lat : S 19 : 38.949 Finish Lon : E 26 : 19.776
 Length : 48.58 km

Transect # : 10
 Start Lat : S 19 : 41.109 Start Lon : E 26 : 23.840
 Finish Lat : S 19 : 41.109 Finish Lon : E 26 : 46.758
 Length : 40.08 km

Transect # : 11
 Start Lat : S 19 : 43.269 Start Lon : E 26 : 45.961
 Finish Lat : S 19 : 43.269 Finish Lon : E 26 : 24.790
 Length : 37.02 km

Transect # : 12
 Start Lat : S 19 : 45.429 Start Lon : E 26 : 29.327
 Finish Lat : S 19 : 45.429 Finish Lon : E 26 : 45.163
 Length : 27.70 km

Transect # : 13
 Start Lat : S 19 : 47.589 Start Lon : E 26 : 44.366
 Finish Lat : S 19 : 47.589 Finish Lon : E 26 : 34.471
 Length : 17.30 km

Transect # : 14
 Start Lat : S 19 : 49.749 Start Lon : E 26 : 35.414

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Finish Lat : S 19 : 49.749 Finish Lon : E 26 : 43.568

Length : 14.26 km

Transect # : 15

Start Lat : S 19 : 51.909 Start Lon : E 26 : 42.770

Finish Lat : S 19 : 51.909 Finish Lon : E 26 : 36.599

Length : 10.79 km

Kazuma

Number of transects : 4

Transect Bearing : 0.00 Degrees

Transect Spacing : 7.90 km

Transect # : 1

Start Lat : S 18 : 16.566 Start Lon : E 25 : 44.130

Finish Lat : S 18 : 21.538 Finish Lon : E 25 : 44.130

Length : 9.21 km

Transect # : 2

Start Lat : S 18 : 25.708 Start Lon : E 25 : 39.640

Finish Lat : S 18 : 12.463 Finish Lon : E 25 : 39.640

Length : 24.53 km

Transect # : 3

Start Lat : S 18 : 13.314 Start Lon : E 25 : 35.151

Finish Lat : S 18 : 27.234 Finish Lon : E 25 : 35.151

Length : 25.78 km

Transect # : 4

Start Lat : S 18 : 20.836 Start Lon : E 25 : 30.661

Finish Lat : S 18 : 13.944 Finish Lon : E 25 : 30.661

Length : 12.76 km

Kazungula

Number of transects : 10

Transect Bearing : 0.00 Degrees

Transect Spacing : 3.40 km

Transect # : 1

Start Lat : S 17 : 56.706 Start Lon : E 25 : 15.466

Finish Lat : S 17 : 49.925 Finish Lon : E 25 : 15.466

Length : 12.56 km

Transect # : 2

Start Lat : S 17 : 48.602 Start Lon : E 25 : 17.393

Finish Lat : S 17 : 56.867 Finish Lon : E 25 : 17.393

Length : 15.30 km

Transect # : 3

Start Lat : S 17 : 57.788 Start Lon : E 25 : 19.320

Finish Lat : S 17 : 49.775 Finish Lon : E 25 : 19.320

Length : 14.84 km

Transect # : 4

Start Lat : S 17 : 50.330 Start Lon : E 25 : 21.247

Finish Lat : S 17 : 57.980 Finish Lon : E 25 : 21.247

Length : 14.17 km

Transect # : 5

Start Lat : S 17 : 58.169 Start Lon : E 25 : 23.175

Finish Lat : S 17 : 50.799 Finish Lon : E 25 : 23.175

Length : 13.65 km

Transect # : 6

Start Lat : S 17 : 50.915 Start Lon : E 25 : 25.102

Finish Lat : S 17 : 58.713 Finish Lon : E 25 : 25.102

Length : 14.44 km

Transect # : 7

Start Lat : S 17 : 59.648 Start Lon : E 25 : 27.029

Finish Lat : S 17 : 50.669 Finish Lon : E 25 : 27.029

Length : 16.63 km

Transect # : 8

Start Lat : S 17 : 51.060 Start Lon : E 25 : 28.956

Finish Lat : S 17 : 57.850 Finish Lon : E 25 : 28.956

Length : 12.57 km

Transect # : 9

Start Lat : S 17 : 57.788 Start Lon : E 25 : 30.883

Finish Lat : S 17 : 51.897 Finish Lon : E 25 : 30.883

Length : 10.91 km

Transect # : 10

Start Lat : S 17 : 54.852 Start Lon : E 25 : 32.811

Finish Lat : S 17 : 57.357 Finish Lon : E 25 : 32.811

Length : 4.64 km

Main Camp

Number of transects : 14

Transect Bearing : 41.00 Degrees

Transect Spacing : 3.50 km

Transect # : 1A

Start Lat : S 18 : 41.104 Start Lon : E 26 : 46.718

Finish Lat : S 18 : 41.451 Finish Lon : E 26 : 46.401

Length : 0.85 km

Transect # : 1B

Start Lat : S 18 : 43.722 Start Lon : E 26 : 44.318

Finish Lat : S 18 : 49.963 Finish Lon : E 26 : 38.596

Length : 15.31 km

Transect # : 2

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Start Lat : S 18 : 50.590 Start Lon : E 26 : 40.662
 Finish Lat : S 18 : 37.941 Finish Lon : E 26 : 52.260
 Length : 31.04 km

Transect # : 3
 Start Lat : S 18 : 39.150 Start Lon : E 26 : 53.793
 Finish Lat : S 18 : 49.690 Finish Lon : E 26 : 44.129
 Length : 25.86 km

Transect # : 4
 Start Lat : S 18 : 49.805 Start Lon : E 26 : 46.665
 Finish Lat : S 18 : 40.359 Finish Lon : E 26 : 55.326
 Length : 23.18 km

Transect # : 5
 Start Lat : S 18 : 41.568 Start Lon : E 26 : 56.859
 Finish Lat : S 18 : 51.304 Finish Lon : E 26 : 47.932
 Length : 23.89 km

Transect # : 6
 Start Lat : S 18 : 53.306 Start Lon : E 26 : 48.738
 Finish Lat : S 18 : 42.777 Finish Lon : E 26 : 58.392
 Length : 25.83 km

Transect # : 7
 Start Lat : S 18 : 43.987 Start Lon : E 26 : 59.924
 Finish Lat : S 18 : 55.097 Finish Lon : E 26 : 49.737
 Length : 27.26 km

Transect # : 8
 Start Lat : S 18 : 56.764 Start Lon : E 26 : 50.850
 Finish Lat : S 18 : 45.196 Finish Lon : E 27 : 1.457
 Length : 28.38 km

Transect # : 9
 Start Lat : S 18 : 46.405 Start Lon : E 27 : 2.990
 Finish Lat : S 18 : 58.529 Finish Lon : E 26 : 51.873
 Length : 29.75 km

Transect # : 10
 Start Lat : S 18 : 59.481 Start Lon : E 26 : 53.642
 Finish Lat : S 18 : 47.614 Finish Lon : E 27 : 4.523
 Length : 29.12 km

Transect # : 11
 Start Lat : S 18 : 48.823 Start Lon : E 27 : 6.056
 Finish Lat : S 19 : 0.412 Finish Lon : E 26 : 55.429
 Length : 28.44 km

Transect # : 12
 Start Lat : S 19 : 2.239 Start Lon : E 26 : 56.396
 Finish Lat : S 18 : 50.032 Finish Lon : E 27 : 7.588
 Length : 29.95 km

Transect # : 13A
 Start Lat : S 18 : 51.242 Start Lon : E 27 : 9.121
 Finish Lat : S 18 : 52.720 Finish Lon : E 27 : 7.765
 Length : 3.63 km

Transect # : 13B
 Start Lat : S 18 : 52.848 Start Lon : E 27 : 7.648
 Finish Lat : S 19 : 3.307 Finish Lon : E 26 : 58.058
 Length : 25.66 km

Transect # : 14A
 Start Lat : S 19 : 4.421 Start Lon : E 26 : 59.678
 Finish Lat : S 18 : 59.780 Finish Lon : E 27 : 3.933
 Length : 11.39 km

Transect # : 14B
 Start Lat : S 18 : 58.748 Start Lon : E 27 : 4.880
 Finish Lat : S 18 : 58.701 Finish Lon : E 27 : 4.923
 Length : 0.12 km

Maitengwe

Number of transects : 6
 Transect Bearing : 0.00 Degrees
 Transect Spacing : 10.00 km

Transect # : 1
 Start Lat : S 19 : 53.573 Start Lon : E 26 : 42.265
 Finish Lat : S 19 : 53.940 Finish Lon : E 26 : 42.265
 Length : 0.68 km

Finish Lat : S 19 : 48.522 Finish Lon : E 26 : 59.459
 Length : 22.77 km

Transect # : 2
 Start Lat : S 19 : 56.963 Start Lon : E 26 : 47.997
 Finish Lat : S 19 : 51.009 Finish Lon : E 26 : 47.997
 Length : 11.03 km

Transect # : 4B
 Start Lat : S 19 : 47.098 Start Lon : E 26 : 59.459
 Finish Lat : S 19 : 40.722 Finish Lon : E 26 : 59.459
 Length : 11.81 km

Transect # : 3
 Start Lat : S 19 : 49.098 Start Lon : E 26 : 53.728
 Finish Lat : S 19 : 58.741 Finish Lon : E 26 : 53.728
 Length : 17.86 km

Transect # : 5
 Start Lat : S 19 : 41.649 Start Lon : E 27 : 5.191
 Finish Lat : S 20 : 2.184 Finish Lon : E 27 : 5.191
 Length : 38.03 km

Transect # : 4A
 Start Lat : S 20 : 0.816 Start Lon : E 26 : 59.459

Transect # : 6
 Start Lat : S 20 : 2.478 Start Lon : E 27 : 10.922
 Finish Lat : S 19 : 44.327 Finish Lon : E 27 : 10.922
 Length : 33.61 km

Matetsi

Number of transects : 4

Transect Bearing : -50.00 Degrees

Transect Spacing : 8.80 km

Transect # : 1

Start Lat : S 18 : 17.965 Start Lon : E 25 : 52.066

Finish Lat : S 18 : 11.087 Finish Lon : E 25 : 43.442

Length : 19.82 km

Transect # : 2

Start Lat : S 18 : 18.655 Start Lon : E 25 : 45.153

Finish Lat : S 18 : 26.271 Finish Lon : E 25 : 54.703

Length : 21.94 km

Transect # : 3

Start Lat : S 18 : 27.950 Start Lon : E 25 : 49.030

Finish Lat : S 18 : 22.767 Finish Lon : E 25 : 42.530

Length : 14.93 km

Transect # : 4

Start Lat : S 18 : 26.181 Start Lon : E 25 : 39.034

Finish Lat : S 18 : 30.447 Finish Lon : E 25 : 44.382

Length : 12.29 km

Mtoa

Number of transects : 20

Transect Bearing : 0.00 Degrees

Transect Spacing : 2.70 km

Transect # : 1

Start Lat : S 18 : 39.293 Start Lon : E 26 : 50.554

Finish Lat : S 18 : 36.831 Finish Lon : E 26 : 50.554

Length : 4.56 km

Length : 0.46 km

Transect # : 2

Start Lat : S 18 : 35.478 Start Lon : E 26 : 49.017

Finish Lat : S 18 : 41.086 Finish Lon : E 26 : 49.017

Length : 10.39 km

Transect # : 8B

Start Lat : S 18 : 35.583 Start Lon : E 26 : 39.798

Finish Lat : S 18 : 47.584 Finish Lon : E 26 : 39.798

Length : 22.22 km

Transect # : 3

Start Lat : S 18 : 40.854 Start Lon : E 26 : 47.481

Finish Lat : S 18 : 33.226 Finish Lon : E 26 : 47.481

Length : 14.12 km

Transect # : 9A

Start Lat : S 18 : 51.439 Start Lon : E 26 : 38.262

Finish Lat : S 18 : 38.894 Finish Lon : E 26 : 38.262

Length : 23.23 km

Transect # : 4A

Start Lat : S 18 : 32.627 Start Lon : E 26 : 45.944

Finish Lat : S 18 : 42.827 Finish Lon : E 26 : 45.944

Length : 18.89 km

Transect # : 9B

Start Lat : S 18 : 37.664 Start Lon : E 26 : 38.262

Finish Lat : S 18 : 37.437 Finish Lon : E 26 : 38.262

Length : 0.42 km

Transect # : 4B

Start Lat : S 18 : 43.614 Start Lon : E 26 : 45.944

Finish Lat : S 18 : 43.755 Finish Lon : E 26 : 45.944

Length : 0.26 km

Transect # : 10

Start Lat : S 18 : 40.040 Start Lon : E 26 : 36.725

Finish Lat : S 18 : 51.173 Finish Lon : E 26 : 36.725

Length : 20.62 km

Transect # : 5

Start Lat : S 18 : 43.679 Start Lon : E 26 : 44.408

Finish Lat : S 18 : 31.809 Finish Lon : E 26 : 44.408

Length : 21.98 km

Transect # : 11

Start Lat : S 18 : 51.355 Start Lon : E 26 : 35.189

Finish Lat : S 18 : 41.987 Finish Lon : E 26 : 35.189

Length : 17.35 km

Transect # : 6

Start Lat : S 18 : 31.216 Start Lon : E 26 : 42.871

Finish Lat : S 18 : 44.385 Finish Lon : E 26 : 42.871

Length : 24.39 km

Transect # : 12

Start Lat : S 18 : 43.071 Start Lon : E 26 : 33.652

Finish Lat : S 18 : 51.573 Finish Lon : E 26 : 33.652

Length : 15.74 km

Transect # : 7

Start Lat : S 18 : 45.620 Start Lon : E 26 : 41.335

Finish Lat : S 18 : 31.860 Finish Lon : E 26 : 41.335

Length : 25.48 km

Transect # : 13

Start Lat : S 18 : 51.514 Start Lon : E 26 : 32.116

Finish Lat : S 18 : 43.277 Finish Lon : E 26 : 32.116

Length : 15.25 km

Transect # : 8A

Start Lat : S 18 : 35.305 Start Lon : E 26 : 39.798

Finish Lat : S 18 : 35.551 Finish Lon : E 26 : 39.798

Transect # : 14

Start Lat : S 18 : 43.496 Start Lon : E 26 : 30.579

Finish Lat : S 18 : 52.332 Finish Lon : E 26 : 30.579

Length : 16.36 km

Transect # : 15

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Start Lat : S 18 : 52.173 Start Lon : E 26 : 29.043
 Finish Lat : S 18 : 44.051 Finish Lon : E 26 : 29.043
 Length : 15.04 km

Transect # : 16
 Start Lat : S 18 : 45.331 Start Lon : E 26 : 27.506
 Finish Lat : S 18 : 52.048 Finish Lon : E 26 : 27.506
 Length : 12.44 km

Transect # : 17
 Start Lat : S 18 : 51.989 Start Lon : E 26 : 25.970
 Finish Lat : S 18 : 46.017 Finish Lon : E 26 : 25.970
 Length : 11.06 km

Transect # : 18
 Start Lat : S 18 : 46.315 Start Lon : E 26 : 24.433
 Finish Lat : S 18 : 51.419 Finish Lon : E 26 : 24.433
 Length : 9.45 km

Transect # : 19
 Start Lat : S 18 : 50.616 Start Lon : E 26 : 22.897
 Finish Lat : S 18 : 47.508 Finish Lon : E 26 : 22.897
 Length : 5.76 km

Transect # : 20
 Start Lat : S 18 : 48.394 Start Lon : E 26 : 21.360
 Finish Lat : S 18 : 48.834 Finish Lon : E 26 : 21.360
 Length : 0.81 km

Ngamo

Number of transects : 17
 Transect Bearing : -52.00 Degrees
 Transect Spacing : 3.40 km

Transect # : 1
 Start Lat : S 19 : 18.985 Start Lon : E 26 : 56.009
 Finish Lat : S 19 : 20.116 Finish Lon : E 26 : 57.538
 Length : 3.40 km

Transect # : 10
 Start Lat : S 19 : 14.366 Start Lon : E 27 : 18.113
 Finish Lat : S 19 : 3.022 Finish Lon : E 27 : 2.777
 Length : 34.12 km

Transect # : 2
 Start Lat : S 19 : 19.847 Start Lon : E 27 : 0.325
 Finish Lat : S 19 : 17.917 Finish Lon : E 26 : 57.715
 Length : 5.81 km

Transect # : 11
 Start Lat : S 19 : 0.938 Start Lon : E 27 : 3.109
 Finish Lat : S 19 : 13.680 Finish Lon : E 27 : 20.335
 Length : 38.33 km

Transect # : 3
 Start Lat : S 19 : 16.648 Start Lon : E 26 : 59.149
 Finish Lat : S 19 : 19.715 Finish Lon : E 27 : 3.296
 Length : 9.23 km

Transect # : 12
 Start Lat : S 19 : 13.722 Start Lon : E 27 : 23.541
 Finish Lat : S 18 : 59.399 Finish Lon : E 27 : 4.179
 Length : 43.08 km

Transect # : 4
 Start Lat : S 19 : 19.374 Start Lon : E 27 : 5.985
 Finish Lat : S 19 : 14.967 Finish Lon : E 27 : 0.027
 Length : 13.26 km

Transect # : 13
 Start Lat : S 18 : 58.035 Start Lon : E 27 : 5.485
 Finish Lat : S 19 : 12.948 Finish Lon : E 27 : 25.645
 Length : 44.86 km

Transect # : 5
 Start Lat : S 19 : 13.488 Start Lon : E 27 : 1.176
 Finish Lat : S 19 : 19.027 Finish Lon : E 27 : 8.665
 Length : 16.66 km

Transect # : 14
 Start Lat : S 19 : 11.989 Start Lon : E 27 : 27.499
 Finish Lat : S 18 : 56.381 Finish Lon : E 27 : 6.397
 Length : 46.95 km

Transect # : 6
 Start Lat : S 19 : 19.240 Start Lon : E 27 : 12.103
 Finish Lat : S 19 : 10.824 Finish Lon : E 27 : 0.725
 Length : 25.32 km

Transect # : 15
 Start Lat : S 18 : 54.870 Start Lon : E 27 : 7.505
 Finish Lat : S 19 : 9.013 Finish Lon : E 27 : 26.625
 Length : 42.54 km

Transect # : 7
 Start Lat : S 19 : 8.107 Start Lon : E 27 : 0.202
 Finish Lat : S 19 : 18.262 Finish Lon : E 27 : 13.930
 Length : 30.54 km

Transect # : 16
 Start Lat : S 19 : 7.053 Start Lon : E 27 : 27.125
 Finish Lat : S 18 : 52.725 Finish Lon : E 27 : 7.756
 Length : 43.10 km

Transect # : 8
 Start Lat : S 19 : 16.706 Start Lon : E 27 : 14.977
 Finish Lat : S 19 : 4.979 Finish Lon : E 26 : 59.123
 Length : 35.27 km

Transect # : 17
 Start Lat : S 18 : 51.422 Start Lon : E 27 : 9.144
 Finish Lat : S 18 : 53.968 Finish Lon : E 27 : 12.585
 Length : 7.66 km

Transect # : 9
 Start Lat : S 19 : 4.440 Start Lon : E 27 : 1.543
 Finish Lat : S 19 : 15.577 Finish Lon : E 27 : 16.600
 Length : 33.50 km

Ngamo Forest

Number of transects : 8

Transect Bearing : 41.00 Degrees

Transect Spacing : 5.20 km

Transect # : 1

Start Lat : S 18 : 58.320 Start Lon : E 27 : 18.118
Finish Lat : S 18 : 46.923 Finish Lon : E 27 : 28.575
Length : 27.97 km

Transect # : 2

Start Lat : S 18 : 47.690 Start Lon : E 27 : 31.799
Finish Lat : S 19 : 0.113 Finish Lon : E 27 : 20.400
Length : 30.48 km

Transect # : 3

Start Lat : S 19 : 1.906 Start Lon : E 27 : 22.682
Finish Lat : S 18 : 48.559 Finish Lon : E 27 : 34.929
Length : 32.75 km

Transect # : 4

Start Lat : S 18 : 49.881 Start Lon : E 27 : 37.642
Finish Lat : S 19 : 3.699 Finish Lon : E 27 : 24.964
Length : 33.90 km

Transect # : 5

Start Lat : S 19 : 5.492 Start Lon : E 27 : 27.247
Finish Lat : S 18 : 52.453 Finish Lon : E 27 : 39.209
Length : 31.99 km

Transect # : 6

Start Lat : S 18 : 53.634 Start Lon : E 27 : 42.053
Finish Lat : S 19 : 5.963 Finish Lon : E 27 : 30.741
Length : 30.25 km

Transect # : 7

Start Lat : S 19 : 5.910 Start Lon : E 27 : 34.717
Finish Lat : S 18 : 55.581 Finish Lon : E 27 : 44.194
Length : 25.34 km

Transect # : 8A

Start Lat : S 18 : 58.545 Start Lon : E 27 : 45.401
Finish Lat : S 19 : 1.351 Finish Lon : E 27 : 42.826
Length : 6.89 km

Transect # : 8B

Start Lat : S 19 : 2.577 Start Lon : E 27 : 41.702
Finish Lat : S 19 : 5.842 Finish Lon : E 27 : 38.706
Length : 8.01 km

Panda Masuie

Number of transects : 8

Transect Bearing : 0.00 Degrees

Transect Spacing : 6.90 km

Transect # : 1

Start Lat : S 18 : 3.676 Start Lon : E 25 : 18.833
Finish Lat : S 17 : 57.571 Finish Lon : E 25 : 18.833
Length : 11.30 km

Transect # : 2

Start Lat : S 17 : 58.110 Start Lon : E 25 : 22.747
Finish Lat : S 18 : 7.173 Finish Lon : E 25 : 22.747
Length : 16.78 km

Transect # : 3

Start Lat : S 18 : 12.445 Start Lon : E 25 : 26.660
Finish Lat : S 17 : 59.650 Finish Lon : E 25 : 26.660
Length : 23.70 km

Transect # : 4

Start Lat : S 17 : 57.805 Start Lon : E 25 : 30.573
Finish Lat : S 18 : 13.960 Finish Lon : E 25 : 30.573
Length : 29.92 km

Transect # : 5

Start Lat : S 18 : 13.344 Start Lon : E 25 : 34.486
Finish Lat : S 17 : 57.617 Finish Lon : E 25 : 34.486
Length : 29.12 km

Transect # : 6

Start Lat : S 18 : 2.479 Start Lon : E 25 : 38.399
Finish Lat : S 18 : 12.718 Finish Lon : E 25 : 38.399
Length : 18.96 km

Transect # : 7A

Start Lat : S 18 : 11.559 Start Lon : E 25 : 42.312
Finish Lat : S 18 : 10.045 Finish Lon : E 25 : 42.312
Length : 2.80 km

Transect # : 7B

Start Lat : S 18 : 4.800 Start Lon : E 25 : 42.312
Finish Lat : S 18 : 2.467 Finish Lon : E 25 : 42.312
Length : 4.32 km

Transect # : 8

Start Lat : S 18 : 9.228 Start Lon : E 25 : 46.226
Finish Lat : S 18 : 9.450 Finish Lon : E 25 : 46.226
Length : 0.41 km

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Robins

Number of transects : 11
Transect Bearing : 90.00 Degrees
Transect Spacing : 3.30 km

Transect # : 1
Start Lat : S 18 : 30.749 Start Lon : E 26 : 10.404
Finish Lat : S 18 : 30.749 Finish Lon : E 26 : 7.806
Length : 4.57 km

Transect # : 2
Start Lat : S 18 : 32.531 Start Lon : E 26 : 1.657
Finish Lat : S 18 : 32.531 Finish Lon : E 26 : 10.145
Length : 14.91 km

Transect # : 3
Start Lat : S 18 : 34.313 Start Lon : E 26 : 11.818
Finish Lat : S 18 : 34.313 Finish Lon : E 25 : 57.447
Length : 25.25 km

Transect # : 4
Start Lat : S 18 : 36.095 Start Lon : E 25 : 52.670
Finish Lat : S 18 : 36.095 Finish Lon : E 26 : 12.027
Length : 34.01 km

Transect # : 5
Start Lat : S 18 : 37.877 Start Lon : E 26 : 12.715
Finish Lat : S 18 : 37.877 Finish Lon : E 25 : 51.988
Length : 36.42 km

Transect # : 6
Start Lat : S 18 : 39.659 Start Lon : E 25 : 47.381
Finish Lat : S 18 : 39.659 Finish Lon : E 26 : 12.175
Length : 43.57 km

Transect # : 7
Start Lat : S 18 : 41.441 Start Lon : E 26 : 12.574
Finish Lat : S 18 : 41.441 Finish Lon : E 25 : 47.903
Length : 43.35 km

Rosslyn

Number of transects : 4
Transect Bearing : 90.00 Degrees
Transect Spacing : 5.00 km

Transect # : 1
Start Lat : S 18 : 37.704 Start Lon : E 25 : 52.041
Finish Lat : S 18 : 37.704 Finish Lon : E 25 : 47.016
Length : 8.83 km

Transect # : 2
Start Lat : S 18 : 35.004 Start Lon : E 25 : 42.409
Finish Lat : S 18 : 35.004 Finish Lon : E 25 : 54.402
Length : 21.07 km

Transect # : 8
Start Lat : S 18 : 43.223 Start Lon : E 25 : 47.408
Finish Lat : S 18 : 43.223 Finish Lon : E 26 : 12.211
Length : 43.58 km

Transect # : 9
Start Lat : S 18 : 45.005 Start Lon : E 26 : 7.680
Finish Lat : S 18 : 45.005 Finish Lon : E 25 : 47.713
Length : 35.09 km

Transect # : 10A
Start Lat : S 18 : 46.787 Start Lon : E 25 : 48.206
Finish Lat : S 18 : 46.787 Finish Lon : E 26 : 2.632
Length : 25.35 km

Transect # : 10B
Start Lat : S 18 : 46.787 Start Lon : E 26 : 3.971
Finish Lat : S 18 : 46.787 Finish Lon : E 26 : 4.659
Length : 1.21 km

Transect # : 11A
Start Lat : S 18 : 48.569 Start Lon : E 25 : 55.917
Finish Lat : S 18 : 48.569 Finish Lon : E 25 : 54.174
Length : 3.06 km

Transect # : 11B
Start Lat : S 18 : 48.569 Start Lon : E 25 : 54.138
Finish Lat : S 18 : 48.569 Finish Lon : E 25 : 52.969
Length : 2.05 km

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Shakwanki

Number of transects : 15

Transect Bearing : 90.00 Degrees

Transect Spacing : 4.50 km

Transect # : 1

Start Lat : S 19 : 32.850 Start Lon : E 26 : 18.489
Finish Lat : S 19 : 32.850 Finish Lon : E 26 : 10.586
Length : 13.85 km

Transect # : 2

Start Lat : S 19 : 30.420 Start Lon : E 26 : 9.474
Finish Lat : S 19 : 30.420 Finish Lon : E 26 : 24.497
Length : 26.32 km

Transect # : 3

Start Lat : S 19 : 27.990 Start Lon : E 26 : 24.419
Finish Lat : S 19 : 27.990 Finish Lon : E 26 : 8.810
Length : 27.34 km

Transect # : 4

Start Lat : S 19 : 25.560 Start Lon : E 26 : 7.568
Finish Lat : S 19 : 25.560 Finish Lon : E 26 : 26.945
Length : 33.94 km

Transect # : 5

Start Lat : S 19 : 23.130 Start Lon : E 26 : 28.225
Finish Lat : S 19 : 23.130 Finish Lon : E 26 : 6.803
Length : 37.53 km

Transect # : 6

Start Lat : S 19 : 20.700 Start Lon : E 26 : 5.807
Finish Lat : S 19 : 20.700 Finish Lon : E 26 : 27.394
Length : 37.81 km

Transect # : 7

Start Lat : S 19 : 18.270 Start Lon : E 26 : 26.739
Finish Lat : S 19 : 18.270 Finish Lon : E 26 : 4.775
Length : 38.47 km

Transect # : 8

Start Lat : S 19 : 15.840 Start Lon : E 26 : 3.769
Finish Lat : S 19 : 15.840 Finish Lon : E 26 : 25.000
Length : 37.19 km

Transect # : 9

Start Lat : S 19 : 13.410 Start Lon : E 26 : 24.045
Finish Lat : S 19 : 13.410 Finish Lon : E 26 : 2.638
Length : 37.50 km

Transect # : 10

Start Lat : S 19 : 10.980 Start Lon : E 26 : 1.146
Finish Lat : S 19 : 10.980 Finish Lon : E 26 : 22.167
Length : 36.82 km

Transect # : 11

Start Lat : S 19 : 8.550 Start Lon : E 26 : 20.947
Finish Lat : S 19 : 8.550 Finish Lon : E 25 : 59.160
Length : 38.16 km

Transect # : 12

Start Lat : S 19 : 6.120 Start Lon : E 25 : 57.793
Finish Lat : S 19 : 6.120 Finish Lon : E 26 : 20.275
Length : 39.38 km

Transect # : 13

Start Lat : S 19 : 3.690 Start Lon : E 26 : 19.701
Finish Lat : S 19 : 3.690 Finish Lon : E 25 : 58.098
Length : 37.84 km

Transect # : 14

Start Lat : S 19 : 1.260 Start Lon : E 26 : 1.075
Finish Lat : S 19 : 1.260 Finish Lon : E 26 : 18.664
Length : 30.81 km

Transect # : 15

Start Lat : S 18 : 58.830 Start Lon : E 26 : 15.924
Finish Lat : S 18 : 58.830 Finish Lon : E 26 : 14.154
Length : 3.10 km

Shapi

Number of transects : 26

Transect Bearing : 0.00 Degrees

Transect Spacing : 2.20 km

Transect # : 1

Start Lat : S 18 : 55.590 Start Lon : E 26 : 50.165
Finish Lat : S 18 : 57.850 Finish Lon : E 26 : 50.165
Length : 4.19 km

Transect # : 2

Start Lat : S 18 : 57.724 Start Lon : E 26 : 48.911
Finish Lat : S 18 : 53.573 Finish Lon : E 26 : 48.911
Length : 7.69 km

Transect # : 3

Start Lat : S 18 : 49.735 Start Lon : E 26 : 47.657
Finish Lat : S 18 : 57.778 Finish Lon : E 26 : 47.657
Length : 14.89 km

Transect # : 4

Start Lat : S 18 : 57.831 Start Lon : E 26 : 46.403
Finish Lat : S 18 : 49.816 Finish Lon : E 26 : 46.403
Length : 14.84 km

Transect # : 5

Start Lat : S 18 : 49.816 Start Lon : E 26 : 45.149
Finish Lat : S 18 : 57.848 Finish Lon : E 26 : 45.149
Length : 14.87 km

Transect # : 6

Start Lat : S 18 : 58.328 Start Lon : E 26 : 43.895
Finish Lat : S 18 : 49.923 Finish Lon : E 26 : 43.895
Length : 15.56 km

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Transect # : 7

Start Lat : S 18 : 50.293 Start Lon : E 26 : 42.641
Finish Lat : S 18 : 58.425 Finish Lon : E 26 : 42.641
Length : 15.06 km

Transect # : 8

Start Lat : S 18 : 58.369 Start Lon : E 26 : 41.387
Finish Lat : S 18 : 50.673 Finish Lon : E 26 : 41.387
Length : 14.25 km

Transect # : 9

Start Lat : S 18 : 50.989 Start Lon : E 26 : 40.133
Finish Lat : S 18 : 58.446 Finish Lon : E 26 : 40.133
Length : 13.81 km

Transect # : 10

Start Lat : S 18 : 58.637 Start Lon : E 26 : 38.879
Finish Lat : S 18 : 51.259 Finish Lon : E 26 : 38.879
Length : 13.66 km

Transect # : 11

Start Lat : S 18 : 51.318 Start Lon : E 26 : 37.625
Finish Lat : S 18 : 59.111 Finish Lon : E 26 : 37.625
Length : 14.43 km

Transect # : 12

Start Lat : S 19 : 0.080 Start Lon : E 26 : 36.371
Finish Lat : S 18 : 51.154 Finish Lon : E 26 : 36.371
Length : 16.53 km

Transect # : 13

Start Lat : S 18 : 51.377 Start Lon : E 26 : 35.117
Finish Lat : S 19 : 0.836 Finish Lon : E 26 : 35.117
Length : 17.52 km

Transect # : 14

Start Lat : S 19 : 1.900 Start Lon : E 26 : 33.863
Finish Lat : S 18 : 51.592 Finish Lon : E 26 : 33.863
Length : 19.09 km

Transect # : 15

Start Lat : S 18 : 51.613 Start Lon : E 26 : 32.609
Finish Lat : S 19 : 2.422 Finish Lon : E 26 : 32.609
Length : 20.02 km

Transect # : 16

Start Lat : S 19 : 2.878 Start Lon : E 26 : 31.356
Finish Lat : S 18 : 52.308 Finish Lon : E 26 : 31.356
Length : 19.57 km

Transect # : 17

Start Lat : S 18 : 52.364 Start Lon : E 26 : 30.102
Finish Lat : S 19 : 3.383 Finish Lon : E 26 : 30.102
Length : 20.41 km

Transect # : 18

Start Lat : S 19 : 3.737 Start Lon : E 26 : 28.848
Finish Lat : S 18 : 52.739 Finish Lon : E 26 : 28.848
Length : 20.37 km

Transect # : 19

Start Lat : S 18 : 53.415 Start Lon : E 26 : 27.594
Finish Lat : S 19 : 4.141 Finish Lon : E 26 : 27.594
Length : 19.86 km

Transect # : 20

Start Lat : S 19 : 5.844 Start Lon : E 26 : 26.340
Finish Lat : S 18 : 53.827 Finish Lon : E 26 : 26.340
Length : 22.25 km

Transect # : 21

Start Lat : S 18 : 54.701 Start Lon : E 26 : 25.086
Finish Lat : S 19 : 6.387 Finish Lon : E 26 : 25.086
Length : 21.64 km

Transect # : 22

Start Lat : S 19 : 6.650 Start Lon : E 26 : 23.832
Finish Lat : S 18 : 55.237 Finish Lon : E 26 : 23.832
Length : 21.13 km

Transect # : 23

Start Lat : S 18 : 55.923 Start Lon : E 26 : 22.578
Finish Lat : S 19 : 7.762 Finish Lon : E 26 : 22.578
Length : 21.92 km

Transect # : 24

Start Lat : S 19 : 8.240 Start Lon : E 26 : 21.324
Finish Lat : S 18 : 58.228 Finish Lon : E 26 : 21.324
Length : 18.54 km

Transect # : 25

Start Lat : S 18 : 58.712 Start Lon : E 26 : 20.070
Finish Lat : S 19 : 5.266 Finish Lon : E 26 : 20.070
Length : 12.14 km

Transect # : 26

Start Lat : S 19 : 1.392 Start Lon : E 26 : 18.816
Finish Lat : S 18 : 59.432 Finish Lon : E 26 : 18.816
Length : 3.63 km

Sikumi Forest

Number of transects : 7

Transect Bearing : 41.00 Degrees

Transect Spacing : 7.90 km

Transect # : 1

Start Lat : S 18 : 38.579 Start Lon : E 26 : 53.070
Finish Lat : S 18 : 32.218 Finish Lon : E 26 : 58.898
Length : 15.61 km

Transect # : 2

Start Lat : S 18 : 34.753 Start Lon : E 27 : 2.532

Finish Lat : S 18 : 41.307 Finish Lon : E 26 : 56.528
Length : 16.08 km

Transect # : 3

Start Lat : S 18 : 44.035 Start Lon : E 26 : 59.986
Finish Lat : S 18 : 37.173 Finish Lon : E 27 : 6.273
Length : 16.84 km

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Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Transect # : 4

Start Lat : S 18 : 37.402 Start Lon : E 27 : 12.020
 Finish Lat : S 18 : 46.763 Finish Lon : E 27 : 3.444
 Length : 22.97 km

Transect # : 5

Start Lat : S 18 : 49.491 Start Lon : E 27 : 6.902
 Finish Lat : S 18 : 41.083 Finish Lon : E 27 : 14.605
 Length : 20.63 km

Transect # : 6

Start Lat : S 18 : 43.318 Start Lon : E 27 : 18.515
 Finish Lat : S 18 : 52.218 Finish Lon : E 27 : 10.361
 Length : 21.84 km

Transect # : 7

Start Lat : S 18 : 54.942 Start Lon : E 27 : 13.823
 Finish Lat : S 18 : 44.862 Finish Lon : E 27 : 23.058
 Length : 24.73 km

Sinamatella

Number of transects : 18

Transect Bearing : 0.00 Degrees

Transect Spacing : 3.20 km

Transect # : 1

Start Lat : S 18 : 33.599 Start Lon : E 26 : 10.634
 Finish Lat : S 18 : 29.199 Finish Lon : E 26 : 10.634
 Length : 8.15 km

Transect # : 2A

Start Lat : S 18 : 27.470 Start Lon : E 26 : 12.454
 Finish Lat : S 18 : 37.137 Finish Lon : E 26 : 12.454
 Length : 17.90 km

Transect # : 2B

Start Lat : S 18 : 38.557 Start Lon : E 26 : 12.454
 Finish Lat : S 18 : 40.208 Finish Lon : E 26 : 12.454
 Length : 3.06 km

Transect # : 2C

Start Lat : S 18 : 40.289 Start Lon : E 26 : 12.454
 Finish Lat : S 18 : 40.299 Finish Lon : E 26 : 12.454
 Length : 0.02 km

Transect # : 2D

Start Lat : S 18 : 40.803 Start Lon : E 26 : 12.454
 Finish Lat : S 18 : 41.016 Finish Lon : E 26 : 12.454
 Length : 0.39 km

Transect # : 3

Start Lat : S 18 : 42.092 Start Lon : E 26 : 14.274
 Finish Lat : S 18 : 25.715 Finish Lon : E 26 : 14.274
 Length : 30.33 km

Transect # : 4

Start Lat : S 18 : 24.886 Start Lon : E 26 : 16.094
 Finish Lat : S 18 : 41.979 Finish Lon : E 26 : 16.094
 Length : 31.65 km

Transect # : 5

Start Lat : S 18 : 47.244 Start Lon : E 26 : 17.914
 Finish Lat : S 18 : 24.188 Finish Lon : E 26 : 17.914
 Length : 42.70 km

Transect # : 6

Start Lat : S 18 : 27.396 Start Lon : E 26 : 19.734
 Finish Lat : S 18 : 47.968 Finish Lon : E 26 : 19.734
 Length : 38.10 km

Transect # : 7

Start Lat : S 18 : 48.308 Start Lon : E 26 : 21.554

Finish Lat : S 18 : 28.767 Finish Lon : E 26 : 21.554
 Length : 36.19 km

Transect # : 8

Start Lat : S 18 : 28.869 Start Lon : E 26 : 23.374
 Finish Lat : S 18 : 47.324 Finish Lon : E 26 : 23.374
 Length : 34.18 km

Transect # : 9

Start Lat : S 18 : 46.105 Start Lon : E 26 : 25.193
 Finish Lat : S 18 : 28.304 Finish Lon : E 26 : 25.193
 Length : 32.96 km

Transect # : 10

Start Lat : S 18 : 27.650 Start Lon : E 26 : 27.013
 Finish Lat : S 18 : 45.798 Finish Lon : E 26 : 27.013
 Length : 33.61 km

Transect # : 11

Start Lat : S 18 : 44.294 Start Lon : E 26 : 28.833
 Finish Lat : S 18 : 27.077 Finish Lon : E 26 : 28.833
 Length : 31.88 km

Transect # : 12

Start Lat : S 18 : 27.187 Start Lon : E 26 : 30.653
 Finish Lat : S 18 : 43.515 Finish Lon : E 26 : 30.653
 Length : 30.24 km

Transect # : 13

Start Lat : S 18 : 43.191 Start Lon : E 26 : 32.473
 Finish Lat : S 18 : 28.176 Finish Lon : E 26 : 32.473
 Length : 27.81 km

Transect # : 14

Start Lat : S 18 : 27.778 Start Lon : E 26 : 34.293
 Finish Lat : S 18 : 42.585 Finish Lon : E 26 : 34.293
 Length : 27.42 km

Transect # : 15

Start Lat : S 18 : 41.208 Start Lon : E 26 : 36.113
 Finish Lat : S 18 : 29.019 Finish Lon : E 26 : 36.113
 Length : 22.57 km

Transect # : 16

Start Lat : S 18 : 30.810 Start Lon : E 26 : 37.933
 Finish Lat : S 18 : 38.931 Finish Lon : E 26 : 37.933
 Length : 15.04 km

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Transect # : 17A

Start Lat : S 18 : 35.603 Start Lon : E 26 : 39.753
Finish Lat : S 18 : 35.531 Finish Lon : E 26 : 39.753
Length : 0.13 km

Transect # : 17B

Start Lat : S 18 : 35.491 Start Lon : E 26 : 39.753
Finish Lat : S 18 : 30.548 Finish Lon : E 26 : 39.753
Length : 9.15 km

Transect # : 18A

Start Lat : S 18 : 30.112 Start Lon : E 26 : 41.573
Finish Lat : S 18 : 31.573 Finish Lon : E 26 : 41.573
Length : 2.71 km

Transect # : 18B

Start Lat : S 18 : 31.691 Start Lon : E 26 : 41.573
Finish Lat : S 18 : 31.848 Finish Lon : E 26 : 41.573
Length : 0.29 km

Tsholotsho East

Number of transects : 7

Transect Bearing : 90.00 Degrees

Transect Spacing : 8.40 km

Transect # : 1

Start Lat : S 19 : 25.064 Start Lon : E 26 : 52.979
Finish Lat : S 19 : 25.064 Finish Lon : E 26 : 58.793
Length : 10.16 km

Transect # : 2

Start Lat : S 19 : 29.600 Start Lon : E 27 : 0.830
Finish Lat : S 19 : 29.600 Finish Lon : E 26 : 50.950
Length : 17.27 km

Transect # : 3

Start Lat : S 19 : 34.136 Start Lon : E 26 : 49.309
Finish Lat : S 19 : 34.136 Finish Lon : E 26 : 57.525
Length : 14.36 km

Transect # : 4

Start Lat : S 19 : 38.672 Start Lon : E 26 : 57.801
Finish Lat : S 19 : 38.672 Finish Lon : E 26 : 47.654
Length : 17.73 km

Transect # : 5

Start Lat : S 19 : 43.208 Start Lon : E 26 : 45.983
Finish Lat : S 19 : 43.208 Finish Lon : E 26 : 58.242
Length : 21.42 km

Transect # : 6

Start Lat : S 19 : 47.744 Start Lon : E 26 : 59.632
Finish Lat : S 19 : 47.744 Finish Lon : E 26 : 44.308
Length : 26.78 km

Transect # : 7

Start Lat : S 19 : 52.280 Start Lon : E 26 : 42.633
Finish Lat : S 19 : 52.280 Finish Lon : E 26 : 44.739
Length : 3.68 km

Tsholotsho North

Number of transects : 8

Transect Bearing : 0.00 Degrees

Transect Spacing : 10.00 km

Transect # : 1

Start Lat : S 19 : 11.809 Start Lon : E 27 : 35.271
Finish Lat : S 19 : 13.485 Finish Lon : E 27 : 35.271
Length : 3.10 km

Transect # : 2

Start Lat : S 19 : 19.677 Start Lon : E 27 : 29.564
Finish Lat : S 19 : 7.315 Finish Lon : E 27 : 29.564
Length : 22.89 km

Transect # : 3

Start Lat : S 19 : 13.622 Start Lon : E 27 : 23.857
Finish Lat : S 19 : 22.491 Finish Lon : E 27 : 23.857
Length : 16.42 km

Transect # : 4

Start Lat : S 19 : 26.637 Start Lon : E 27 : 18.150
Finish Lat : S 19 : 14.348 Finish Lon : E 27 : 18.150
Length : 22.76 km

Transect # : 5

Start Lat : S 19 : 19.204 Start Lon : E 27 : 12.443
Finish Lat : S 19 : 24.271 Finish Lon : E 27 : 12.443
Length : 9.38 km

Transect # : 6

Start Lat : S 19 : 23.969 Start Lon : E 27 : 6.736
Finish Lat : S 19 : 19.307 Finish Lon : E 27 : 6.736
Length : 8.63 km

Transect # : 7

Start Lat : S 19 : 19.802 Start Lon : E 27 : 1.030
Finish Lat : S 19 : 24.515 Finish Lon : E 27 : 1.030
Length : 8.73 km

Transect # : 8

Start Lat : S 19 : 22.942 Start Lon : E 26 : 55.323
Finish Lat : S 19 : 21.185 Finish Lon : E 26 : 55.323
Length : 3.25 km

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Zambezi NP

Number of transects : 6
Transect Bearing : 0.00 Degrees
Transect Spacing : 5.40 km

Transect # : 1
Start Lat : S 17 : 52.967 Start Lon : E 25 : 31.690
Finish Lat : S 17 : 51.577 Finish Lon : E 25 : 31.690
Length : 2.57 km

Transect # : 2
Start Lat : S 17 : 50.526 Start Lon : E 25 : 34.752
Finish Lat : S 17 : 58.057 Finish Lon : E 25 : 34.752
Length : 13.95 km

Transect # : 3
Start Lat : S 18 : 2.481 Start Lon : E 25 : 37.814
Finish Lat : S 17 : 50.325 Finish Lon : E 25 : 37.814
Length : 22.51 km

Transect # : 4
Start Lat : S 17 : 48.578 Start Lon : E 25 : 40.876
Finish Lat : S 18 : 2.472 Finish Lon : E 25 : 40.876
Length : 25.73 km

Transect # : 5
Start Lat : S 18 : 2.462 Start Lon : E 25 : 43.937
Finish Lat : S 17 : 50.465 Finish Lon : E 25 : 43.937
Length : 22.22 km

Transect # : 6
Start Lat : S 17 : 51.611 Start Lon : E 25 : 46.999
Finish Lat : S 18 : 0.062 Finish Lon : E 25 : 46.999
Length : 15.65 km

Zanguja

Number of transects : 6
Transect Bearing : 29.00 Degrees
Transect Spacing : 7.00 km

Transect # : 1
Start Lat : S 18 : 27.479 Start Lon : E 26 : 12.533
Finish Lat : S 18 : 22.450 Finish Lon : E 26 : 15.467
Length : 10.65 km

Transect # : 2
Start Lat : S 18 : 20.014 Start Lon : E 26 : 12.339
Finish Lat : S 18 : 31.352 Finish Lon : E 26 : 5.723
Length : 24.01 km

Transect # : 3
Start Lat : S 18 : 32.935 Start Lon : E 26 : 0.250
Finish Lat : S 18 : 17.115 Finish Lon : E 26 : 9.482
Length : 33.50 km

Transect # : 4
Start Lat : S 18 : 17.901 Start Lon : E 26 : 4.473
Finish Lat : S 18 : 35.062 Finish Lon : E 25 : 54.460
Length : 36.34 km

Transect # : 5
Start Lat : S 18 : 28.096 Start Lon : E 25 : 53.975
Finish Lat : S 18 : 18.290 Finish Lon : E 25 : 59.697
Length : 20.76 km

Transect # : 6
Start Lat : S 18 : 20.204 Start Lon : E 25 : 54.031
Finish Lat : S 18 : 20.275 Finish Lon : E 25 : 53.989
Length : 0.15 km

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Appendix 4. Transect summaries of sightings

Species codes:

Code	Species
Bab	Baboon
Bbk	Bushbuck
Buff	Buffalo
Catt	Cattle
Chet	Cheetah
Croc	Crocodile
Dkr	Common or Bush Duiker
Donk	Donkeys
EIC1	Elephant carcass, age category 1
EIC2	Elephant carcass, age category 2
EIC3	Elephant carcass, age category 3
EIC4	Elephant carcass, age category 4
Eld	Eland
EleF	Elephant cow
EleM	Elephant bull
Ghb	Ground hornbill
Gems	Gemsbok
Grf	Giraffe
Hipo	Hippopotamus
Hyn	Hyaena
Imp	Impala
Klip	Klipspringer
Kudu	Kudu
Lion	Lion
Ost	Ostrich
Roan	Roan antelope
Sab	Sable antelope
Sbk	Steenbok
Shoa	Sheep and/or goats
UnCa	Unidentified carcass
Water	Pan containing water
Wbk	Waterbuck
Wbst	Wildebeest
Whog	Warthog
Zeb	Zebra

Other abbreviations

Abbreviation	Meaning
n	number of transects sampled
N	possible number of transects in stratum
t	Student's <i>t</i> value, $P = 0.05$
T #	transect number
-	that no animals were seen in search the strips

The following tables list, for each stratum, the number of individuals of each species that were seen inside the search strips on each transect.

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Date of Survey : 15/10/14

Stratum Locality : North-west Matabeleland

Stratum Area : 769 sq km

N : 149 n : 10

Pilot : Charles Mackie

Stratum Name : Central A

Base Line Length : 45.2 km

Calibrated Strip Width at 300 ft : 299 m

t : 2.262

Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC3	EIC4	UnCa	Sab	Grf	Dkr
1	0	0	0	0	0	0	0	0
2	3	0	0	0	0	0	0	0
3	0	3	0	0	0	0	0	0
4	0	39	0	1	0	0	0	0
5	3	35	0	1	0	0	0	0
6	0	6	0	0	0	0	0	0
7	1	0	0	0	0	1	0	0
8	2	9	1	0	0	0	0	0
9	11	22	2	1	0	0	1	1
10	3	6	1	1	1	0	0	0

Sighting Totals

	EleM	EleF	EIC3	EIC4	UnCa	Sab	Grf	Dkr
	23	120	4	4	1	1	1	

Date of Survey : 23/10/14

Stratum Locality : North-west Matabeleland

Stratum Area : 1720 sq km

N : 141 n : 9

Pilot : Charles Mackie

Stratum Name : Central B

Base Line Length : 42.3 km

Calibrated Strip Width at 300 ft : 299 m

t : 2.306

Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC4	Grf	Kudu	Eld	Sbk
1	0	23	1	0	0	0	0
2	0	8	0	0	0	0	0
3	0	0	0	2	0	0	1
4	1	0	2	0	1	0	1
5	0	0	0	2	0	0	0
6	0	0	1	0	0	0	0
7	0	0	1	0	0	0	0
8	0	0	1	0	0	2	0
9	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC4	Grf	Kudu	Eld	Sbk
	1	31	6	4	1	2	2

Date of Survey : 07/10/14

Stratum Name : Kazuma

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Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Stratum Locality : North-west Matabeleland
 Stratum Area : 551 sq km
 N : 106 n : 4
 Pilot : Charles Mackie

Base Line Length : 32.7 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 3.182
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleF	EIC1	EIC3	EIC4	Grf	Kudu	Eld	Roan
1	0	0	0	0	0	0	0	0
2	6	0	2	2	1	4	0	1
3	0	0	0	2	0	0	5	0
4	0	0	0	0	0	0	0	0

Sighting Totals

	EleF	EIC1	EIC3	EIC4	Grf	Kudu	Eld	Roan
	6	0	2	4	1	4	5	1

Date of Survey : 21/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 1203 sq km
 N : 169 n : 6
 Pilot : Charles Mackie

Stratum Name : Maitengwe
 Base Line Length : 51.1 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.571
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleF	UnCa	Catt	Shoa	Donk	Dkr
1	0	0	0	0	0	0
2	0	0	7	0	0	0
3	0	0	0	0	0	0
4	25	0	14	0	10	1
5	0	1	13	20	0	0
6	0	0	54	3	3	0

Sighting Totals

	EleF	UnCa	Catt	Shoa	Donk	Dkr
	25	1	88	23	13	1

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Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 08/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 697 sq km
 N : 136 n : 4
 Pilot : Charles Mackie

Stratum Name : Matetsi
 Base Line Length : 41.6 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 3.182
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleF	EIC4	UnCa	Imp	Zeb	Grf	Kudu	Wbk	Eld	Ghb	Croc
1	4	1	1	0	6	1	1	0	8	0	0
2	30	0	0	3	5	0	0	8	0	0	0
3	10	0	1	15	0	0	0	20	0	0	1
4	0	0	0	0	0	0	0	0	0	5	0

Sighting Totals

	EleF	EIC4	UnCa	Imp	Zeb	Grf	Kudu	Wbk	Eld	Ghb	Croc
	44	1	2	18	11	1	1	28	8	5	1

Date of Survey : 17/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 1174 sq km
 N : 143 n : 8
 Pilot : Charles Mackie

Stratum Name : Ngamo Forest
 Base Line Length : 44.1 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.365
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC3	EIC4	Grf	Catt	Shoa	Donk	Bab
1	0	0	0	3	0	0	0	0	2
2	0	9	0	0	0	15	0	0	0
3	0	0	0	0	0	0	0	0	0
4	1	18	0	1	2	0	0	0	0
5	14	24	1	1	0	0	10	0	0
6	0	0	0	1	0	0	0	0	0
7	0	0	0	0	0	3	0	0	0
8	0	0	0	1	0	42	63	1	0

Sighting Totals

	EleM	EleF	EIC3	EIC4	Grf	Catt	Shoa	Donk	Bab
	15	51	1	7	2	60	73	1	2

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Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 09/10/14

Stratum Locality : North-west Matabeleland

Stratum Area : 955 sq km

N : 175 n : 8

Pilot : Charles Mackie

Stratum Name : Panda Masuie

Base Line Length : 54.4 km

Calibrated Strip Width at 300 ft : 299 m

t : 2.365

Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleF	EIC2	EIC3	EIC4	UnCa	Sab	Zeb	Grf	Ost	Bab
1	0	0	0	1	0	0	0	0	0	0
2	0	0	0	0	1	0	0	0	0	0
3	0	1	1	1	0	0	0	1	1	0
4	60	0	0	1	1	0	5	0	0	0
5	0	0	0	0	0	5	0	5	0	5
6	0	0	0	2	0	0	0	0	0	0
7	0	0	0	1	0	0	0	2	0	0
8	0	0	0	0	0	0	0	0	0	0

Sighting Totals

	EleF	EIC2	EIC3	EIC4	UnCa	Sab	Zeb	Grf	Ost	Bab
	60	1	1	6	2	5	5	8	1	5

Date of Survey : 09/10/14

Stratum Locality : North-west Matabeleland

Stratum Area : 349 sq km

N : 71 n : 4

Pilot : Charles Mackie

Stratum Name : Rosslyn

Base Line Length : 21.9 km

Calibrated Strip Width at 300 ft : 299 m

t : 3.182

Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EIC4	Imp	Sab	Zeb	Grf	Kudu
1	0	0	0	3	1	0
2	2	0	0	4	0	0
3	0	0	8	0	0	0
4	1	15	20	46	0	8

Sighting Totals

	EIC4	Imp	Sab	Zeb	Grf	Kudu
	3	15	28	53	1	8

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Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 17/10/14

Stratum Locality : North-west Matabeleland

Stratum Area : 2148 sq km

N : 217 n : 15

Pilot : Charles Mackie

Stratum Name : Shakwanki

Base Line Length : 66.6 km

Calibrated Strip Width at 300 ft : 299 m

t : 2.145

Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC3	EIC4	UnCa	Imp	Grf	Whog	Eld	Roan	Sbk	Rbk?
1	0	0	0	0	0	0	0	0	0	2	0	1
2	0	0	0	0	0	0	0	0	0	0	0	0
3	0	4	0	0	0	0	1	0	0	0	0	0
4	0	0	0	0	0	6	0	0	0	0	0	0
5	0	0	0	0	0	0	4	0	0	0	0	0
6	0	2	0	0	1	0	1	0	0	0	0	0
7	0	0	1	0	1	0	0	0	0	0	0	0
8	0	0	2	0	0	0	0	0	0	0	0	0
9	0	0	0	3	1	0	0	0	0	0	0	0
10	1	0	2	0	0	10	1	1	0	0	0	0
11	3	8	2	1	0	0	2	0	0	0	1	0
12	6	8	0	1	0	0	0	0	0	0	0	0
13	3	2	0	0	0	0	0	0	2	0	0	0
14	3	52	1	1	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC3	EIC4	UnCa	Imp	Grf	Whog	Eld	Roan	Sbk	Rbk?
	16	76	8	6	3	16	9	1	2	2	1	1

DRAFT ONLY

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 16/10/14

Stratum Locality : North-west Matabeleland

Stratum Area : 913 sq km

N : 189 n : 26

Pilot : Charles Mackie

Stratum Name : Shapi

Base Line Length : 57.5 km

Calibrated Strip Width at 300 ft : 299 m

t : 2.06

Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC3	EIC4	UnCa	Buff	Sab	Zeb	Grf	Eld	Ost
1	0	7	1	0	0	0	0	0	0	0	0
2	0	11	0	0	0	0	0	0	0	0	0
3	4	0	1	1	1	0	0	0	0	0	1
4	12	95	0	0	0	0	0	0	0	0	0
5	2	39	1	0	0	0	0	0	0	0	0
6	3	57	0	0	0	0	0	0	0	0	0
7	1	100	1	0	0	0	0	0	0	0	0
8	2	101	0	2	0	0	0	0	0	0	0
9	3	25	1	0	0	0	0	0	0	0	0
10	3	24	0	2	0	0	0	0	0	0	0
11	12	21	0	0	1	0	2	0	0	0	0
12	2	0	0	1	1	0	0	0	0	0	0
13	3	65	0	1	0	0	0	5	11	0	0
14	3	33	0	1	1	0	0	0	0	0	0
15	5	43	0	1	0	0	0	0	0	0	0
16	10	20	0	0	0	1	0	0	0	0	0
17	3	39	0	0	0	0	1	0	1	0	0
18	1	26	0	1	0	0	0	0	0	0	0
19	4	41	0	1	0	0	0	0	0	0	0
20	36	25	0	0	0	0	0	0	0	0	0
21	20	67	0	1	0	7	0	0	0	0	0
22	4	73	0	3	1	2	0	0	0	0	0
23	3	53	1	1	0	0	0	0	0	0	0
24	0	8	0	1	0	0	0	0	0	1	0
25	0	2	0	1	0	0	0	0	0	0	0
26	2	0	0	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC3	EIC4	UnCa	Buff	Sab	Zeb	Grf	Eld	Ost
	138	975	6	18	5	10	3	5	12	1	1

DRAFT ONLY

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 16/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 1158 sq km
 N : 197 n : 7
 Pilot : Charles Mackie

Stratum Name : Sikumi Forest
 Base Line Length : 60.4 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.447
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EIC2	EIC3	EIC4	UnCa	Buff	Sab	Grf	Kudu	Wbst	Shoa	Bab
1	1	1	2	2	0	0	0	0	0	0	0
2	0	0	0	1	0	0	1	3	0	0	0
3	0	1	0	0	0	0	0	0	0	25	0
4	0	0	0	0	0	35	0	0	0	0	9
5	0	0	0	0	45	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	30	0	0
7	0	0	2	1	0	0	0	0	0	0	0

Sighting Totals

	EIC2	EIC3	EIC4	UnCa	Buff	Sab	Grf	Kudu	Wbst	Shoa	Bab
	1	2	4	4	45	35	1	3	30	25	9

Date of Survey : 18/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 914 sq km
 N : 189 n : 7
 Pilot : Charles Mackie

Stratum Name : Tsholotsho East
 Base Line Length : 57.8 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.447
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleF	UnCa	Catt	Shoa	Donk
1	0	0	0	0	0
2	0	0	12	0	0
3	0	1	24	0	0
4	0	0	0	0	4
5	55	0	0	0	0
6	0	0	24	0	0
7	0	0	76	40	0

Sighting Totals

	EleF	UnCa	Catt	Shoa	Donk
	55	1	136	40	4

DRAFT ONLY

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 22/10/14

Stratum Locality : North-west Matabeleland

Stratum Area : 958 sq km

N : 247 n : 8

Pilot : Charles Mackie

Stratum Name : Tsholotsho North

Base Line Length : 73.1 km

Calibrated Strip Width at 300 ft : 299 m

t : 2.365

Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	Catt	Shoa	Donk
1	2	0	0
2	22	14	9
3	11	42	9
4	8	18	3
5	2	0	0
6	0	2	0
7	30	0	0
8	0	0	0

Sighting Totals

	Catt	Shoa	Donk
	75	76	21

DRAFT ONLY

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 15-16/10/2014
 Stratum Locality : North-west Matabeleland
 Stratum Area : 1279 sq km
 N : 236 n : 29
 Pilot : Charles Mackie

Stratum Name : Dandari
 Base Line Length : 72.1 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.048
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC3	EIC4	UnCa	Buff	Imp	Sab	Zeb	Grf	Kudu	Whog	Gems	Hipo
1	4	0	0	1	0	0	0	0	0	0	0	0	0	0
2	4	4	0	1	0	0	0	0	0	0	0	0	0	0
3	0	25	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1	0	0	3	0	0	0	0	0	0	0	0	0	0
6	1	6	0	0	3	0	0	0	0	0	0	0	0	0
7	4	0	0	0	2	0	0	0	0	0	0	0	0	0
8	8	0	0	0	0	1	1	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	2	17	0	1	0	0	0	0	0	0	0	0	0	0
11	4	0	0	0	2	0	0	0	0	0	0	0	0	0
12	0	0	0	0	1	1	0	0	0	0	0	0	0	0
13	0	0	0	0	0	2	1	0	0	0	0	0	0	0
14	0	0	0	0	1	0	0	0	0	0	0	0	0	0
15	4	11	0	1	0	0	0	0	0	0	0	0	0	0
16	4	17	0	1	0	0	0	0	0	0	0	0	0	0
17	6	0	2	3	0	1	6	1	0	40	0	0	3	0
18	2	65	2	3	1	0	0	0	0	0	0	0	0	0
19	0	25	1	6	1	0	0	0	0	0	0	0	0	0
20	4	14	0	5	0	0	0	0	0	0	0	0	0	0
21	4	48	1	3	0	0	0	1	0	0	1	7	1	0
22	1	19	0	0	0	0	0	0	0	0	0	0	0	0
23	3	21	0	2	0	0	0	0	0	0	0	0	0	1
24	1	9	0	1	0	0	0	0	0	0	0	1	0	0
25	1	68	0	1	0	0	0	0	0	0	0	1	0	0
26	3	34	0	0	0	0	0	0	0	0	0	0	0	0

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

27	13	33	0	2	0	0	0	0	0	0	0
28	0	0	0	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC3	EIC4	UnCa	Buff	Imp	Sab	Zeb	Grf	Kudu	Whog	Gems	Hipo
	74	416	7	45	4	1	41	1	7	6	1	2	1	4

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 18/10/14

Stratum Locality : North-west Matabeleland

Stratum Area : 2104 sq km

N : 209

n : 15

Pilot : Charles Mackie

Stratum Name : Dzivanini

Base Line Length : 62.7 km

Calibrated Strip Width at 300 ft : 299 m

t : 2.145

Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC2	EIC3	EIC4	UnCa	Buff	Imp	Zeb	Grf	Kudu	Whog	Eld	Roan	Catt	Shoa	Ghb	Hyn
1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
3	5	10	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	10	0	1	0	0	0	0	0	0	0	4	0	0	0	0	0	0
5	4	10	1	5	0	2	0	0	0	0	6	0	0	0	0	0	0	0
6	1	17	2	7	2	0	0	3	1	0	0	1	0	0	0	0	3	0
7	4	27	0	0	1	0	0	20	0	0	0	0	0	0	0	0	0	1
8	3	18	0	0	1	1	0	25	20	0	0	0	0	0	0	0	0	0
9	7	65	0	0	1	0	50	0	7	0	0	0	0	0	0	0	4	0
10	1	17	0	0	0	1	0	0	0	0	0	3	20	0	0	0	0	0
11	2	33	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	1	0	0	0	0	0	0	0	0	0	0	40	0	0	0
15	4	0	0	0	2	0	0	0	0	0	0	0	0	0	15	0	0	0

Sighting Totals

	EleM	EleF	EIC2	EIC3	EIC4	UnCa	Buff	Imp	Zeb	Grf	Kudu	Whog	Eld	Roan	Catt	Shoa	Ghb	Hyn
	33	207	3	15	12	4	51	25	30	27	4	4	20	1	55	0	7	1

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 08/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 437 sq km
 N : 113 n : 10
 Pilot : Charles Mackie

Stratum Name : Kazungula
 Base Line Length : 35.2 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.262
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC2	EIC3	EIC4	UnCa	Imp	Zeb	Grf	Kudu	Bab	Hipo	Chet
1	0	0	1	3	2	0	0	0	0	2	0	0	0
2	0	0	0	0	1	0	0	0	0	0	0	0	0
3	0	0	0	0	4	0	0	0	0	0	0	2	0
4	0	0	0	0	1	0	15	0	0	0	0	0	1
5	0	0	0	1	3	0	0	0	0	0	0	0	2
6	0	0	0	0	1	0	0	0	0	0	0	0	0
7	0	0	0	0	2	2	0	0	0	0	0	0	0
8	0	10	0	0	0	0	0	3	3	2	0	0	0
9	1	0	0	0	2	0	0	0	0	0	3	0	0
10	3	0	0	0	1	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC2	EIC3	EIC4	UnCa	Imp	Zeb	Grf	Kudu	Bab	Hipo	Chet
	4	10	1	4	17	2	15	3	3	4	5	2	1

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 13/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 1253 sq km
 N : 169 n : 14
 Pilot : Charles Mackie

Stratum Name : Main Camp
 Base Line Length : 51.1 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.16
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC2	EIC3	EIC4	UnCa	Imp	Sab	Zeb	Grf	Kudu	Wbk	Roan	Ghb	Bab	Lion
1	0	0	2	5	2	0	0	0	0	0	0	0	0	0	0	2
2	9	89	0	3	2	0	0	21	0	6	0	0	0	0	0	0
3	0	23	0	3	3	0	0	3	15	2	0	0	0	0	0	0
4	4	77	0	0	2	1	0	0	0	0	8	0	0	0	0	2
5	1	43	0	1	6	0	10	0	0	0	1	4	0	0	0	0
6	0	0	2	2	2	0	0	0	0	0	0	0	0	3	0	0
7	2	94	0	0	1	0	0	0	0	0	0	0	0	0	0	0
8	5	40	0	1	2	1	0	1	0	0	0	0	4	0	0	0
9	0	34	0	4	1	1	0	0	0	0	9	0	0	0	0	0
10	4	21	0	0	0	0	0	0	0	0	0	0	0	2	0	0
11	3	9	0	0	5	2	0	0	0	0	6	0	0	0	0	0
12	27	122	0	1	1	0	0	0	0	0	1	11	0	0	0	1
13	2	10	1	3	0	1	0	0	0	0	0	0	0	0	0	0
14	0	31	0	0	1	0	0	6	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC2	EIC3	EIC4	UnCa	Imp	Sab	Zeb	Grf	Kudu	Wbk	Roan	Ghb	Bab	Lion
	57	593	1	20	31	8	10	31	21	18	20	4	4	5	2	3

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 13/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 824 sq km
 N : 176 n : 20
 Pilot : Charles Mackie

Stratum Name : Mtoa
 Base Line Length : 53.7 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.093
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC1	EIC3	EIC4	UnCa	Sab	Zeb	Grf	Kudu	Eld
1	0	0	1	0	0	0	0	0	0	0	0
2	1	0	0	1	1	0	0	0	0	0	0
3	0	0	0	0	0	1	1	0	0	4	0
4	0	0	1	0	0	0	2	0	0	0	0
5	0	0	0	0	1	0	0	0	0	0	0
6	3	0	0	0	1	0	0	0	0	0	0
7	0	14	0	0	0	0	0	0	0	0	0
8	2	18	0	1	5	0	0	0	0	0	0
9	1	0	0	1	1	0	0	0	1	0	0
10	1	0	0	0	0	2	0	0	1	1	0
11	1	0	0	0	0	0	0	0	0	0	0
12	0	27	0	0	1	0	0	0	0	0	0
13	2	66	0	0	0	0	0	0	5	0	0
14	0	7	0	0	0	0	0	0	1	0	0
15	6	0	0	0	0	0	0	0	0	5	5
16	10	17	0	0	1	0	0	0	1	0	0
17	4	12	0	0	0	0	0	0	0	0	0
18	4	0	0	1	0	0	0	0	1	0	0
19	7	18	0	0	0	0	8	1	0	0	0
20	0	0	0	1	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC1	EIC3	EIC4	UnCa	Sab	Zeb	Grf	Kudu	Eld
	42	179	1	4	14	3	3	8	11	10	5

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 22/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 1630 sq km
 N : 183 n : 17
 Pilot : Charles Mackie

Stratum Name : Ngamo
 Base Line Length : 56.1 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.12
 Observers : Colum Zhuwau, Greg Nyague

Transect summary table :

T #	EleM	EleF	EIC1	EIC2	EIC3	EIC4	UnCa	Buff	Imp	Sab	Zeb	Grf	Whog	Wbk	Roan	Sbk	Hipo
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	26	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
3	3	0	3	0	0	0	1	0	0	0	0	0	0	0	0	1	0
4	4	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
5	4	2	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
6	1	9	0	1	1	0	0	0	0	0	0	1	0	0	0	1	0
7	5	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
8	5	29	0	0	0	1	0	0	16	0	0	0	0	0	2	0	0
9	4	26	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
10	4	84	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
11	12	44	0	0	0	3	0	0	0	0	0	3	1	0	2	0	0
12	7	88	0	0	0	4	3	0	0	0	0	0	1	0	0	0	0
13	19	144	0	0	0	2	0	0	0	0	0	14	0	0	3	0	0
14	8	23	0	0	1	6	1	60	0	0	0	0	0	0	0	0	0
15	17	73	0	0	1	0	0	0	0	31	0	0	0	0	0	0	0
16	1	52	0	0	0	5	1	1	6	13	0	3	0	0	0	0	5
17	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC1	EIC2	EIC3	EIC4	UnCa	Buff	Imp	Sab	Zeb	Grf	Whog	Wbk	Roan	Sbk	Hipo
	95	614	3	1	5	26	6	61	22	44	27	8	1	2	5	2	5

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 10/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 1017 sq km
 N : 117 n : 11
 Pilot : Charles Mackie

Stratum Name : Robins
 Base Line Length : 35.3 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.228
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC4	UnCa	Buff	Imp	Zeb	Kudu	Whog	Wbk	Eld	Ost	Ghb	Bbk	Hyn
1	0	16	0	0	0	0	0	0	0	2	0	0	0	0	0
2	0	2	0	0	0	0	0	2	5	5	0	0	0	0	0
3	9	0	0	1	0	0	3	1	2	8	0	0	0	0	0
4	0	60	1	0	0	12	9	3	0	0	0	0	0	3	5
5	19	10	1	1	0	0	0	0	4	12	0	0	0	0	0
6	3	57	0	0	0	24	4	3	7	0	1	0	0	0	1
7	6	25	3	0	5	5	36	2	1	0	23	0	0	0	0
8	9	76	3	0	0	0	20	0	0	0	0	0	0	0	0
9	0	71	2	0	5	0	0	0	0	0	0	5	0	0	0
10	1	88	4	0	0	0	0	0	0	0	0	0	0	0	0
11	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC4	UnCa	Buff	Imp	Zeb	Kudu	Whog	Wbk	Eld	Ost	Ghb	Bbk	Hyn
	49	405	14	2	10	41	72	11	19	27	24	5	3	5	1

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 12/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 1511 sq km
 N : 1822 n : 18
 Pilot : Charles Mackie

Stratum Name : Sinamatella
 Base Line Length : 56.5 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.11
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC4	UnCa	Buff	Imp	Zeb	Grf	Kudu	Whog	Wbk	Ghb	Bab	Hipo	Croc	Klip	Lion
1	1	6	0	0	0	60	0	0	0	13	0	10	0	0	0	0	0
2	7	9	0	0	0	15	0	0	0	0	0	2	0	0	0	0	0
3	3	9	3	0	0	0	0	0	0	0	3	0	0	0	0	0	0
4	0	0	6	0	0	9	0	1	0	0	1	0	0	4	2	0	0
5	10	90	5	0	0	23	0	0	4	3	0	0	0	0	0	2	2
6	3	24	6	0	0	0	0	0	0	1	0	0	0	0	0	0	0
7	8	3	2	1	2	0	5	0	0	1	0	2	0	0	0	0	0
8	0	21	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
9	5	1	0	0	0	0	0	2	0	2	0	0	0	1	0	0	0
10	0	23	0	0	0	15	6	0	0	0	0	0	0	0	0	0	0
11	0	10	1	1	0	22	3	0	0	4	0	0	0	20	0	0	0
12	11	24	2	0	0	0	3	0	0	0	3	0	0	0	0	0	0
13	1	87	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0
14	2	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	50	1	1	60	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	2	16	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC4	UnCa	Buff	Imp	Zeb	Grf	Kudu	Whog	Wbk	Ghb	Bab	Hipo	Croc	Klip	Lion
	53	382	26	3	62	144	17	6	10	12	17	5	33	4	2	2	2

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 08/10/14
Stratum Locality : North-west Matabeleland
Stratum Area : 548 sq km
N : 103 n : 6
Pilot : Charles Mackie

Stratum Name : Zambezi NP
Base Line Length : 32 km
Calibrated Strip Width at 300 ft : 299 m
t : 2.571
Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleF	EIC3	EIC4	Buff	Imp	Sab	Zeb	Grf	Kudu	Whog	Wbk
1	0	0	0	100	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	4	0	0
3	0	1	1	0	0	0	0	2	0	0	0
4	0	0	1	0	1	0	15	0	0	1	4
5	3	0	4	0	0	0	0	0	0	6	0
6	0	0	0	0	2	0	0	0	0	0	0

Sighting Totals

	EleF	EIC3	EIC4	Buff	Imp	Sab	Zeb	Grf	Kudu	Whog	Wbk
	3	1	6	100	1	2	15	2	4	7	4

Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland (Zimbabwe): 2014

Date of Survey : 12/10/14
 Stratum Locality : North-west Matabeleland
 Stratum Area : 847 sq km
 N : 130 n : 6
 Pilot : Charles Mackie

Stratum Name : Zanguja
 Base Line Length : 39.4 km
 Calibrated Strip Width at 300 ft : 299 m
 t : 2.571
 Observers : Colum Zhuwau, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC4	UnCa	Imp	Sab	Zeb	Grf	Kudu	Wbk	Eld	Roan	Ghb	Bab
1	0	10	0	0	2	0	4	0	0	0	0	0	0	0
2	4	32	1	0	0	0	1	0	1	0	0	0	4	0
3	2	15	0	1	8	5	1	0	3	6	1	0	0	3
4	1	10	0	0	0	0	5	1	0	3	0	0	0	0
5	0	0	0	0	5	0	10	0	1	0	3	2	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC4	UnCa	Imp	Sab	Zeb	Grf	Kudu	Wbk	Eld	Roan	Ghb	Bab
	7	67	1	1	15	5	21	1	5	9	4	2	4	3

Appendix 5. Comparison of observers

Introduction

The numbers and sizes of groups seen by the two observers were compared to determine if the observers appeared to be similarly efficient.

Methods

For each of the commoner species, the total numbers and the average sizes of the groups seen by each observer in all transects were determined. For each observer/species, the numbers of groups that an observer was expected to see (if the observers were equally efficient and animals similarly distributed on the two sides of the aircraft) were calculated as:

$$\text{Expected Number} = \frac{\text{Total Number} \times \text{Observer's Strip Width}}{\text{Total Strip Width for both Observers}}$$

where:

Expected Number = the number of groups of a given species that an observer was expected to count if the two observers saw similar numbers;

Total Number = the total number of groups of a given species actually counted by both observers;

Observer's Strip Width = the width (in metres) of the search strip of one observer when the aircraft was flying at 300 feet above ground level; and

Total Strip Width for both Observers = the combined calibrated strip width (in metres) for both observers when the aircraft was flying at 300 feet above ground level (Appendix 1).

For each species, the observed and expected numbers of groups were compared using a chi-square one-sample statistical test with 1 degree of freedom (Siegel 1956). No test was conducted for a species if either expected number was <5. For each species, the average sizes of the groups seen by the two observers were compared with a Mann-Whitney U two-tailed test.

Results

The left observer saw significantly more elephant bull groups and elephant cow herds than the right observer (Table A5.1). He also saw more elephant carcasses in age categories 3 and 4, as well as more groups of giraffe and ground hornbill (Table A5.1).

The left observer saw smaller groups of donkeys and larger groups of impala than the right observer, but for all other species there was no significant difference between the observers in the group sizes seen (Table A5.1).

Discussion

The observers for this survey were the same as for the 2014 Sebungwe survey. During the Sebungwe survey, there were no differences between these observers in the rates at which elephant bull groups or cow herds were seen within the respective search strips. But a few weeks later, during the north-west Matabeleland survey, the left observer saw significantly more elephant groups in his search strip than the right observer saw in his. There are no differences between observers in the sizes of elephant groups seen and so the difference in

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the number of groups cannot be accounted for by the right observer calling fewer but larger groups than the left observer.

Within his search strip, the left observer saw 342 bulls (190 groups x 1.8 mean group size) and the right observer saw 262 bulls (138 x 1.9). Similarly, the left observer saw 2568 elephants in cow herds (262 x 9.8) and the right observer saw 1740 (174 x 10).

If one assumes that the differences in group number occurred solely because the left observer was more efficient than the right one (and, for the sake of simplicity, ignores the small difference in strip width between the two observers), then one can suggest that if the right observer had been as efficient as the left one, the number of bulls seen would increase from 604 ($342 + 262$) to 684 (2×342), an increase of 13 %. Similarly, the number of elephants in cow herds seen would increase from 4308 ($2568 + 1740$) to 5136 (2×2568), an increase of 19 %. The population estimate for all elephants would increase by 18 %.

However, that approach may be too simple. Elephant groups seen by the observers but which they judged to be outside their search strip were also recorded during the survey. The left observer saw a total (inside and outside his strip) of 723 elephant bulls and the right observer saw 700 bulls. The left observer saw a total of 4638 elephants in cow herds and the right observer saw 4648. For both bulls and cows, the figures for left and right are remarkably similar. They suggest that the observers were equally efficient at spotting elephants, but that – for whatever reason – the left observer judged a greater proportion of the groups that he saw to be inside the search strip than did the right observer.

Turning now to the elephant carcasses, the total number (inside and outside the strip) of carcasses category 3 or 4 seen by the left observer was 260 and by the right observer was 159. This large difference suggests that the left observer was more efficient than the right observer at spotting elephant carcasses. If the left and right observers had been similarly efficient, the number of carcasses 3 or 4 seen inside the search strips would increase from 331 ($221 + 110$) to 442 (2×221), an increase of 33 %.

Reference

- Siegel, S. 1956. *Nonparametric Statistics for the Behavioral Sciences*. McGraw-Hill Kogakusha Ltd, Tokyo. 312 pp.

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Table A5.1. Comparison of numbers and sizes of groups seen by the left and right observers

Expected numbers of groups were proportional to the observers' strip widths. No chi-square test was conducted if any expected number was <5 . P_N indicates the probability of the observed numbers of groups if there was no difference in the efficiency of the two observers. P_s indicates the probability of the observed sizes of groups if there was no difference in the efficiency of the two observers. ns = not significant.

Species / observation	Observed number of groups				Expected number of groups				Mean size of groups		Chi-square	P_N	U	P_s
	Left		Right		Left		Right		Left		Right			
	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right				
Buffalo	4	10	7	7	3.5	32.6	2.6	ns	16	ns				
Carcass elephant 1	1	2	1	2	2.0	1.0					6	ns		
Carcass elephant 2	4	4	4	4	1.3	1.0					618	ns		
Carcass elephant 3	45	28	36	37	1.1	1.1					5544	ns		
Carcass elephant 4	157	72	113	116	1.1	1.1					33.8	<0.001		
Carcass unidentified	21	31	26	26	1.0	1.0					ns	325.5	ns	
Cattle	25	25	25	25	7.2	9.4	0.0	ns	286	ns				
Donkeys	8	5	6	7	2.1	4.4	1.2	ns	7.5	0.028				
Eland	4	8	6	6	6.3	5.8	1.3	ns	12	ns				
Elephant bull	190	138	161	167	1.8	1.9	10.3	0.001	12520	ns				
Elephant cow	262	174	214	222	9.8	10.0	21.1	<0.001	21828	ns				
Giraffe	37	23	29	31	2.1	2.0	4.3	0.039	408.5	ns				
Ground hornbill	8	1	4	5	3.0	5.0	7.2	0.007	0	ns				
Impala	16	13	14	15	16.4	7.8	0.6	ns	51.5	0.010				
Kudu	18	17	17	18	2.4	2.5	0.1	ns	139.5	ns				
Sable	12	10	11	11	9.1	4.9	0.2	ns	48	ns				
Sheep/Goat	8	9	8	9	14.6	13.3	0.0	ns	25.5	ns				
Warthog	11	12	11	12	1.7	2.3	0.0	ns	58	ns				
Waterbuck	10	7	8	9	4.7	6.3	0.9	ns	28.5	ns				
Zebra	24	20	22	22	7.4	5.9	0.4	ns	225.5	ns				

Appendix 6. Maintenance of flying height

The intended height for flying the survey was 300 feet agl. The mean height flown was 305 feet agl ($SD = 27.8$ feet, $SE = 0.5$ feet, $n = 3130$ observations). Variation in the flying height is influenced by both the undulating nature of the terrain in the survey area, and by the pilot's ability to maintain the desired flying height.

The pilot, aircraft and other equipment for this survey were identical to that for the 2014 survey of elephants in the Sebungwe which occurred just a few weeks earlier. The variability in flying height for the north-west Matabeleland survey (as indexed by the SD) was less than half the variability recorded for the Sebungwe survey, reflecting the generally flat terrain of north-west Matabeleland and the more rugged terrain of the Sebungwe.

The laser rangefinder worked only up to a maximum distance of 500 feet and hence a few records (0.06 %) that should have been >500 feet were recorded as simply 500 feet.

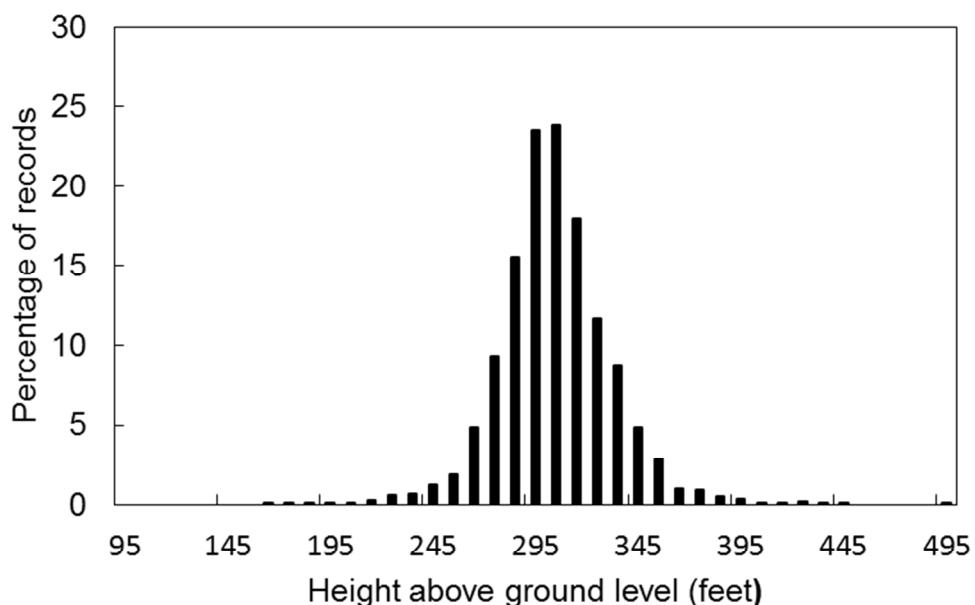


Fig. A6.1. Distribution of flying height above ground level

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Appendix 7. Calibration of laser rangefinder

On two occasions, readings from the laser rangefinder (no. MP6314030) were compared with those from the plane's barometric altimeters. This was done by flying the plane immediately above and parallel to the airstrip, ideally six times – twice at 400 feet agl, twice at 300 ft and twice at 200 ft. To facilitate this, the pilot would arbitrarily zero his altimeter and so the readings from the pilot's altimeter are relative, not absolute. On the pilot's say, one of the observers would note the reading of the laser rangefinder and the recorder would note the reading of the co-pilot's altimeter. That the airstrip was not flat and level prevented more than one reading during each flight down the runway.

For each occasion, the reading from the laser rangefinder was regressed first against the reading from the altimeter and then against the reading from the co-pilot's altimeter. For each regression, the slope of the linear regression was determined.

For pilot's altimeter

6 Oct, slope (b) = 1.143, SE of b = 0.031;

16 Oct: b = 0.80, SE of b = 0.087;

Co-pilot's altimeter

6 Oct, b = 1.138, SE of b = 0.036;

16 Oct: b = 0.784, SE of b = 0.096;

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Table A7.1. Comparison of readings from laser rangefinder and barometric altimeters

Date	Pilot's barometric altimeter (ft)	Co-pilot's barometric altimeter (ft)	Laser rangefinder (ft)
6 Oct 14	400	4040	405
	400	4100	427
	300	4000	307
	200	3900	209
	200	3880	199
	100	3760	66
	100	3790	78
	300	4000	312
16 Oct 14	400	4368	400
	400	4400	446
	300	4270	352
	200	4190	268
	300	-	352
	200	-	258

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