

**Aerial Survey of Elephants and other Large Herbivores
in the Zambezi Valley (Zimbabwe): 2014**

K.M. Dunham, C.S. Mackie & G. Nyaguse

April 2015, revised October 2015



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**Great Elephant Census
Vulcan Inc., 505 Fifth Ave S, Suite 900,
Seattle, WA 98104, USA**

This survey was conducted in partnership with the Zimbabwe Parks and Wild Life
Management Authority

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



An earlier version of this report, dated April 2015, was produced by the Parks and Wild Life Management Authority, Zimbabwe. Since production of that report, the survey sponsor – the Great Elephant Census – has completed a review of the survey. Following this, a new appendix (Appendix 9) and two footnotes are included in this revised version of the report.

The April 2015 report and this revised report are identical except for the addition of Appendix 9 and the footnotes, and a few minor editorial changes.

Summary

Elephants and other large herbivores, wild and domestic, were surveyed from the air in the national park, safari areas and communal lands of the Zambezi Valley of northern Zimbabwe during June-August 2014. Fixed-wing aircraft were used to conduct a sample survey, flying transects over the valley floor and block counts in the hilly remainder. The area surveyed totalled 17003 km² and included Mana Pools National Park, Charara, Hurungwe, Sapi, Chewore, Dande and Doma Safari Areas, the Mavuradonha Wilderness Area, and communal lands, most of which were in Guruve District. The area was divided into 26 strata and sampling intensity in the transect strata varied between strata, ranging from 3.1 to 41 %, with greater intensity in strata expected (on the basis of previous survey results) to contain greater densities of elephants. The overall sampling intensity was 12.6 %. 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 11657 (upper and lower 95% confidence limits \pm 19.4 %); buffalo 6330 (\pm 59.7 %); zebra 675 (\pm 66.7 %); waterbuck 481 (\pm 72.1 %); sable 161 (\pm 120 %); impala 4099 (\pm 39.6 %); hippopotamus 2921 (\pm 36.6 %); kudu 358 (\pm 69.2 %); cattle 17896 (\pm 69.1 %) and sheep and goat 13315 (\pm 66.3 %).

The estimated total number of all elephant carcasses (724) represented 5.8 % of the estimated total number of live and dead elephants. This carcass 'ratio' compared with an estimate of 3.9 % 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 0.12 %, which compared with 0.23 % during 2001.

There have been significant declines since 2001 in the population estimates for elephant (-40 %), elephant cows (-47 %), buffalo (-58 %), eland (-82 %), sable (-75 %), zebra (-60 %), kudu (-80 %) and impala (-59 %).

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Introduction

Elephant and other large herbivores, both wild and domestic, were censused in the Zambezi Valley of northern 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 parts of the Zambezi Valley was surveyed during 2003 (Dunham 2004), but the last survey covering the entire elephant subpopulation range was during 2001 (Mackie 2002).

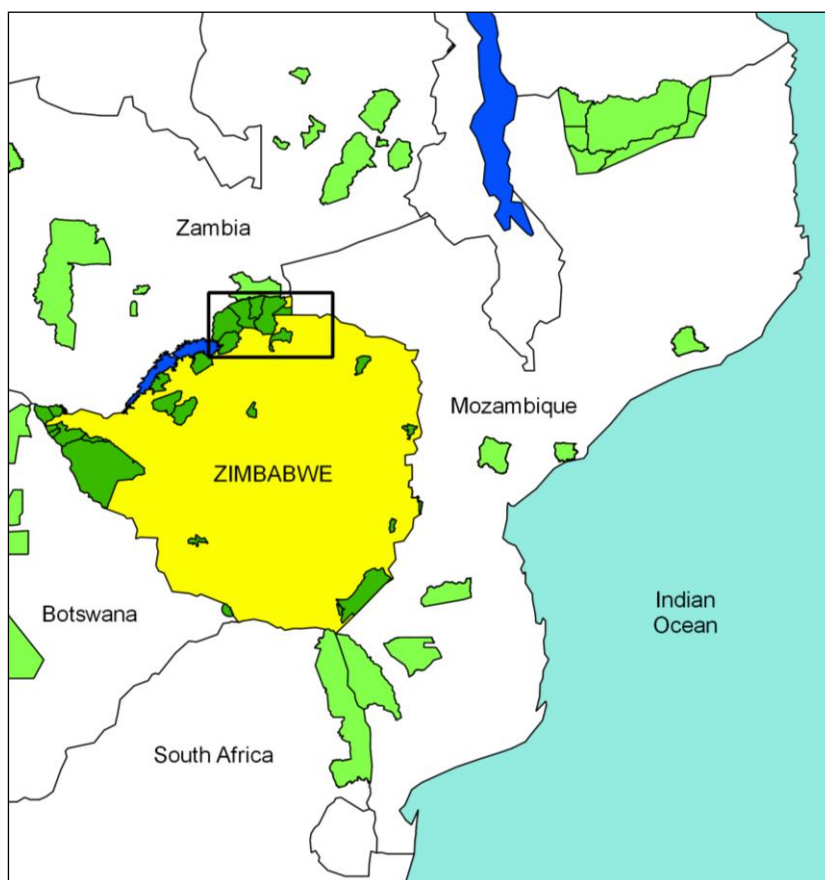
The Zambezi Valley survey area is the second largest block of Parks and Wild Life Estate in Zimbabwe (after Hwange NP). Previously, the southwards movement of elephants was restricted by game fences erected as part of tsetse fly control programmes and the shooting of elephants that broke these fences, but these fences are no longer functional. Elephants can and do move northwards across the Zambezi River into Zambia (Dunham 1986), with Zambia's Lower Zambezi NP lying immediately north of the survey area.

The methods used during this survey were similar to those used during the 2001 survey of the wildlife populations of the Zambezi Valley. 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.

Survey Area

The survey area, located in the very north of Zimbabwe and bordered by the Zambezi River, covered 17003 km² and was divided into 26 strata (Map 4 and Table 3). The overall survey area was the same as that covered during previous surveys of this region (Mackie 2002).

The survey area centred on Mana Pools NP and included Charara and Hurungwe Safari Areas to the west and Sapi, Chewore and Dande Safari Areas to the east, and Doma Safari Area to the south-east (Map 2). Communal lands immediately east of Chewore SA and lying in Guruve district were also surveyed, as was Mavuradonha Wilderness Area (MWA) further east.



Map 1. Location of the Zambezi Valley survey area in northern 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.

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 26 strata, 14 of which were sampled with transects, while the remaining 12 – in hilly terrain – were sampled with blocks.

Transect surveys

The boundaries of the strata in the Zambezi Valley 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. This exercise revealed that the boundary between the strata Chewore III and Chewore IV (Escarpment) was not the same for the two strata, being previously defined by digital co-ordinates for Chewore III and by a line on a 1:50000 paper map for Chewore IV. Consequently, there have been some changes to the calculated areas of the strata and the overall survey area, which now has a calculated area of 17003 km², compared with 17127 km² during 2001 for the same piece of land.

The Kadze stratum of 2001 (Mackie 2002) was divided approximately in half for the 2014 survey in order to remove the need for long transects. The revised stratification doubled the number of transects flown in the Kadze area, but halved their length.

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 3 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 in the transect strata was planned to be 15 %, with a transect width (i.e. combined width of the two search strips) of 300 m. The planned sampling intensity in each transect stratum was determined by using the mean of the elephant densities in each stratum during 2001 and 2003 (Mackie 2002, Dunham 2004) as the predicted elephant densities in equation 1 of Gibson (1989a). 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 1.5 km in strata expected to contain numerous elephants, to 7.5 km in strata expected to contain few or no elephants (Table 3). During the transect flying, it became clear that the overall sampling intensity was too high if the survey was to be completed in the time available and hence transect spacing was doubled in some strata, namely Sapi South, Chewore I, Chewore III and Dande.¹

¹ In addition, three planned transects (numbers 14, 16, 18) were not flown in stratum Mana II.

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.

Block counts

For 12 strata with very hilly terrain, sample units (blocks) were defined during planning for the 2001 survey on maps of scale 1:50000 using linear features (e.g. streamlines, watersheds, vehicle tracks) which were navigable from the air. The size of the blocks was usually in the range of 5-25 km². Block boundaries were unchanged for this 2014 survey. Blocks to be searched were selected by using computer-generated pseudo-random numbers as map coordinates. Consequently, the probability of a block being selected for survey was proportional to its area (Caughley 1977). Blocks to be searched were selected with replacement (Caughley & Sinclair 1994). In other words, a block could be selected more than once (and included more than once in the analysis), although it was searched just once.

Flight Procedures

Transect surveys

All transect strata were surveyed during the period 21 to 31 August 2014 (Table 3).

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).

The aircraft was equipped with a Garmin GPSMAP 295 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 a Garmin GPSMAP 62 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 Douglas Kuramba and Greg Nyaguse. Both had prior experience as survey observers. Greg had extensive experience as a survey observer and most recently was an observer for the Zambezi Valley block counts during July 2014. Douglas had more limited, and no recent, experience. The observers were 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.

Block counts

The block count strata were surveyed during the period 27 June to 11 July 2014 (Table 3). The two-month gap between the block counts and the transect surveys was less than ideal, but was a consequence of the difficulty of safely flying light aircraft at low level over the escarpment hills during the late dry season, when wind speeds are generally greater. There was a similar gap between the block counts and transect surveys during 2001.

Key points on the boundary of a block to be searched were entered as waypoints in a Garmin GPSMAP 295 and a route connecting these waypoints. The pilot (Martin Henriksen) and one observer (Greg Nyaguse or Kevin Dunham) in a Piper Super Cub aircraft searched the block until they believed that all animals within it had been seen and recorded. The Super Cub can safely fly slower than the plane used for the strip counts. The location of each group seen was recorded as a waypoint in a Garmin GPSMAP 62sc GPS receiver and the tracklog facility of this receiver was used to record the flight path of the aircraft. The time taken to search each block was recorded. Prior to the surveys, the pilot and observer were advised to search each block for a period equivalent to approximately one minute per square kilometre.

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, each observer’s strip width (in meters) was adjusted to 300 feet above ground level as follows:

$$\text{Observer's strip width at 300 feet} = \frac{\text{Actual strip width} \times 300}{\text{Actual flying height}}$$

The strip widths, after adjustment to 300 feet above ground level, were then averaged for each observer to give the nominal (calibrated) strip width at 300 feet. This was 170 m for the left observer and 162 m for the right observer (Appendices 1 and 5).

Readings from the laser rangefinder were compared with those from the plane's barometric altimeter (Appendix 8).

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. The observers were tested on their ability to estimate group size (Appendix 7). Groups of elephant bulls were differentiated from elephant cow herds (i.e. herds containing calves), although the latter may have included some bulls (Appendix 5).

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 new carcass categories differ from those used the 2001 survey of this region, when only three categories were used (Mackie 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. Ground hornbills are large and conspicuous birds and any seen were counted.

Data Analysis

Transect surveys

Population estimates and 95 % confidence limits for individual strata were calculated using Jolly's (1969) method 2 for unequal-sized sample units. For the reasons given in Appendix 5, only observations by the right observer were used to calculate these population estimates and confidence limits for the strata sampled with transects. Given the mean right-side 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 strip width for each transect was determined. The actual 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 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.

Block counts

For block count strata, population estimates and confidence intervals for individual strata were calculated using Jolly's (1969) method 3 for unequal-sized sample units selected randomly with a probability proportional to their area.

For all block count strata, n = number of blocks sampled in stratum. Block selection was with replacement and so when one or more blocks were selected more than once, these blocks were included more than once in the analysis, although they were searched just once (Jolly 1969). In these circumstances, n = number of blocks sampled, which was greater than the number searched.

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 (e.g. 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. When population estimates were based on data from just one observer, instead of the usual two, the calculated search effort was halved to provide an measure of effort that was comparable with analyses using data from two observers. 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 3). For the transect surveys, the mean ground speed was 166 km per hour (Table 3) and for >94 % of transects, the mean speed was <190 km per hour². For the transect surveys, 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 2, 3 and 4), unidentified carcasses, buffalo, zebra, sable, waterbuck, impala, warthog, kudu, eland, hippopotamus, cattle, sheep and goats, donkey, ground hornbill and large crocodiles are given in Tables 4 to 10 and 12 to 25 respectively. Estimates are given for each stratum, for various land units within the survey area (Mana Pools NP, Hurungwe SA, Sapi SA, Chewore SA, Charara SA and the communal lands of Guruve District) and for the entire survey area, i.e. the Zambezi Valley. In addition, a separate summary table is provided for the Zambezi Valley (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.

² Of the 12 transects with a mean ground speed >190 km per hour, one or two (total 9) were in each of six strata. The remaining three were in Chapoto stratum, where there was a large difference in ground speed between the three transects flown westwards (mean speed = 211 km per hour) and the four transects flown eastwards (mean speed = 143 km per hour). This difference is the consequence of flying when the wind speed was relatively high (these numbers suggest 34 km per hour) and probably from the east, creating a strong tail wind when flying west and a strong headwind when flying east. Just two groups of 8 and 10 elephants was seen in Chapoto stratum, both on one of the fast transects. Chapoto stratum was estimated to contain 3.6 % of the total elephant population. There is no reason to believe that any elephants within the search strips of the fast transects were missed by the observers, but if a group of, for example, 9 elephants was missed, the difference between the calculated and actual totals for all elephants would be <2 %.

Table 1. Summary of population estimates and statistics for major wildlife species, domestic livestock and elephant carcasses in the Zambezi Valley during August 2014

Species	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Elephant	11657	1122	1292716	19.4	9398	13915	0.69
Elephant bull	2560	242	144739	29.5	1804	3316	0.15
Elephant cow	9098	880	1147977	23.4	6965	11231	0.54
Carcass elephant 1	0	0	0	0	0	0	0
Carcass elephant 2	13	1	182	236.5	1	45	0.001
Carcass elephant 3	18	2	166	150.6	2	44	0.001
Carcass elephant 4	693	55	9689	28.2	497	888	0.04
Carcass elephant all	724	58	10037	27.5	525	922	0.04
Unidentified carcass	37	4	332	102.5	4	75	0.002
Buffalo	6330	629	3575559	59.7	2552	10107	0.37
Cattle	17896	645	27322902	69.1	5536	30257	1.05
Donkey	9	3	74	277.6	3	33	0.001
Eland	145	16	6417	112.5	16	309	0.01
Ground Hornbill	36	5	755	154.1	5	92	0.002
Hippopotamus	2921	325	283427	36.6	1853	3990	0.17
Impala	4099	428	664590	39.6	2475	5724	0.24
Kudu	358	30	14184	69.2	110	606	0.02
Sable	161	26	7811	119.6	26	354	0.01
Sheep/Goat	13315	487	14675911	66.3	4481	22149	0.78
Warthog	342	31	13210	66.8	114	571	0.02
Waterbuck	481	52	29318	72.1	134	828	0.03
Zebra	675	63	48870	66.7	224	1125	0.04

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 Tables 1 and 4, one can say that there were between 9398 and 13915 elephants in the Zambezi Valley, with 11657 being the best estimate of the number of elephants in the region. For practical purposes, one might say that there were between 9000 and 14000 elephants in the Zambezi Valley during the 2014 dry season, with 11500 being the best estimate of the number of elephants there.

Small numbers of baboon and grey duiker were seen during the survey, but no attempt has been made to estimate the numbers of these species. No roan antelope, rhinoceros, or elephant carcass category 1 were seen during the survey.

Animal Distributions

The spatial distribution of the principal wild herbivores is shown in Maps 6 to 8 and 11 to 19. 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 varied between strata (Map 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 20 and 21.

The estimated number of poachers' camps in the Zambezi Valley was small (13, with 95% confidence limits 1 and 45). Just one camp was seen - in the North Charara stratum.

Comparison of Observers

As a consequence of the differences between the observers (Appendix 5), population estimates for the transect strata were calculated using only observations by the right observer.

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 the Zambezi Valley was 0.12 % during 2014 (Table 11).

The estimated number of all elephant carcasses regardless of age category was 724 (CI 199) during 2014 and the all-carcass ratio was 5.8 %. If it is assumed that all 'unidentified' carcasses were elephant carcasses, then the all-carcass ratio increases to 6.1 %.

Temporal Variation in Animal Numbers in the Zambezi Valley

Aerial surveys of the wildlife in the Zambezi Valley were often incomplete in terms of the area covered, because of the difficulty of operating fixed-wing aircraft in the hills of the Zambezi escarpment and northern Chewore during the late dry season (e.g. the 2003 survey did not cover the Chewore Hills (Dunham 2004)). Temporal variation in the numbers of the major wildlife species in the Zambezi Valley is illustrated here using the data from the 1980, 1989, 1993, 1995, 1998, 2001 and 2014 surveys (Bowler 1995, Cumming, Dunham, Robertson & Swanepoel unpubl. data, Cumming, Taylor & Mackie 1997, Davies *et al.* 1996, Gibson 1989b, 1999, Mackie 1995, 2002, Mackie & Taylor 1993). Even this comparison is not without its complications: the communal lands east of the Chewore SA were not surveyed during 1989; the southern Charara SA was not surveyed during 1980-1993 (during which period it was separated from the remainder of the survey area by a tsetse fly control game-fence and any elephants crossing to the south of that fence were likely to be shot); the Doma SA was not surveyed during 1989-1995; and Mavuradonha Wilderness Area was not surveyed during 1980, 1989, or 1998 (the Wilderness Area was formed during the early 1990s).

Before 1998, the Zambezi Valley Parks and Wild Life Estate and the communal lands of the east of this estate were surveyed independently, but from 1998 onwards, both areas were covered during a single survey. The earliest surveys were usually of elephant and a few other species, e.g. buffalo and black rhinoceros during the 1980 survey. In later years the range of species surveyed was widened: by 1995, all medium-sized and large herbivores (i.e. impala upwards) were included. Also, from 1998, all elephants were distinguished as elephants in bull groups, or elephants in cow or breeding herds.

The statistical significance of changes in estimated number since 2001 (the year of the last nationwide elephant survey in Zimbabwe) was determined using a two-tailed *t* test (Gasaway *et al.* 1986) (Table 2). The analyses reveal that there have been declines since 2001 in the population estimates for elephant, elephants in cow herds, buffalo, eland, impala, kudu, sable and zebra. In contrast, the numbers of domestic livestock (cattle and sheep/goats) in the communal lands in the eastern part of the survey area had not declined since 2001.

The estimated number of elephants increased prior to 2001 and peaked during the 2001 survey. But for buffalo and sable, the population declines noted since 2001 appear to have started earlier, before the 2001 survey (Figs 7 and 8). The estimated numbers of cattle and sheep/goats in the communal lands increased during the 1990s and remain relatively high (Figs 14 and 15).

Table 2. Statistical significance of changes in the estimated numbers of large herbivores, domestic livestock and elephant carcasses in the Zambezi Valley 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	19297	13.1	11657	19.4	4.479	<0.001	-40
Elephant bulls	2062	23.4	2560	29.5	1.108	0.270	
Elephant cows	17237	14.3	9098	23.4	4.954	<0.001	-47
Elephant carcass 1	14	140.3	0	0	1.442		
Elephant carcass 2	30	113.4	13	236.5	0.762	0.452	
Elephant carcass 3	749	27.0	18	150.6	7.352	<0.001	-98
Elephant carcass 4	-	-	693	28.2	7.036		
Elephant carcass all	793	25.9	724	27.5	0.486		
Unidentified carcass	575	32.0	37	102.5	6.015	<0.001	-94
Buffalo	14909	35.0	6330	59.7	2.654	0.009	-58
Cattle	8148	47.1	17896	69.1	1.750	0.114	
Eland	805	63.6	145	112.5	2.463	0.016	-82
Impala	10117	25.5	4099	39.6	3.933	<0.001	-59
Kudu	1823	22.1	358	69.2	6.211	<0.001	-80
Sable	656	58.1	161	119.6	2.382	0.021	-75
Sheep / Goat	13643	47.4	13315	66.3	0.065	0.949	
Waterbuck	777	34.3	481	72.1	1.360	0.177	
Zebra	1672	28.7	675	66.7	3.053	0.003	-60

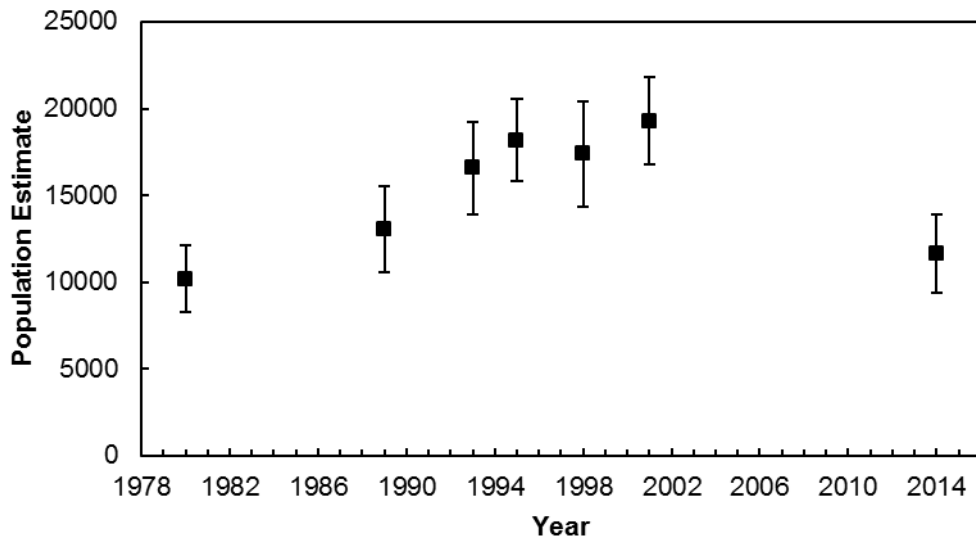


Fig. 1. Number of elephant estimated to be in the Zambezi Valley since 1980

Mean population estimates and 95% confidence intervals shown.

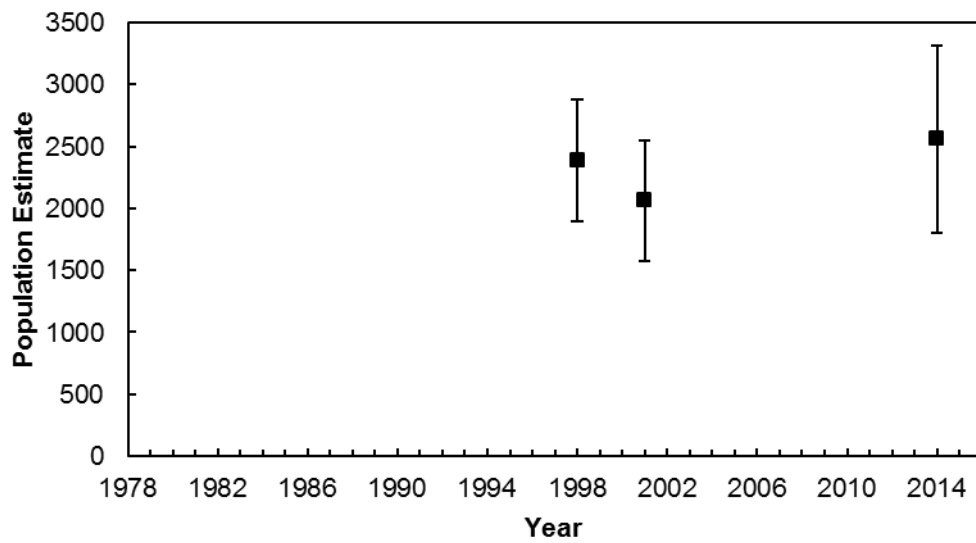


Fig. 2. Number of elephant bulls estimated to be in the Zambezi Valley since 1998

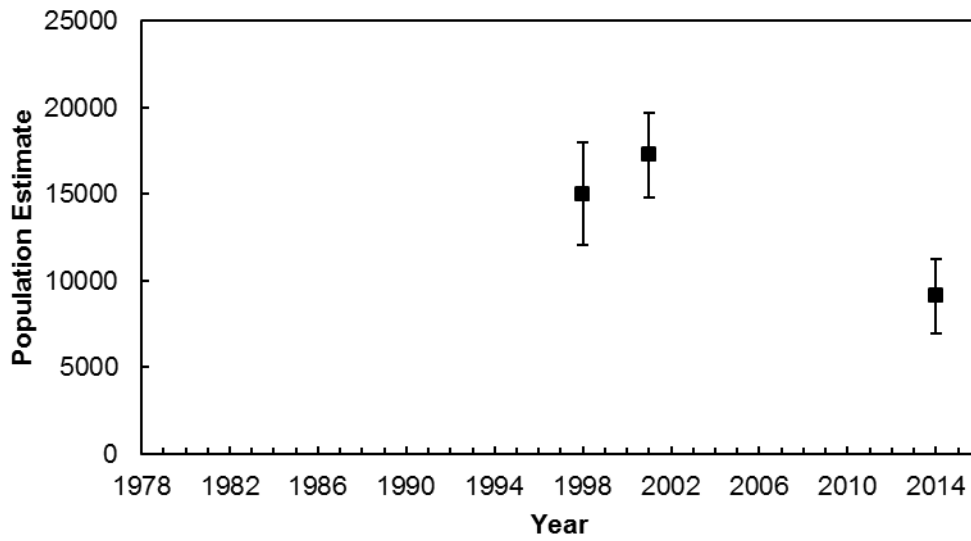


Fig. 3. Number of elephants in cow herds estimated to be in the Zambezi Valley since 1998

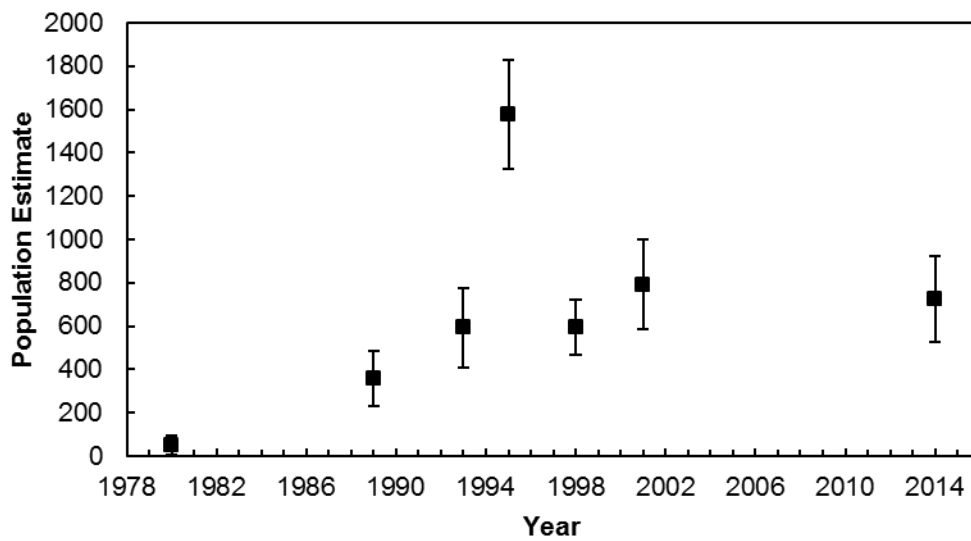


Fig. 4. Number of elephant carcasses estimated to be in the Zambezi Valley since 1980

Estimates based on elephant carcasses in all age categories.

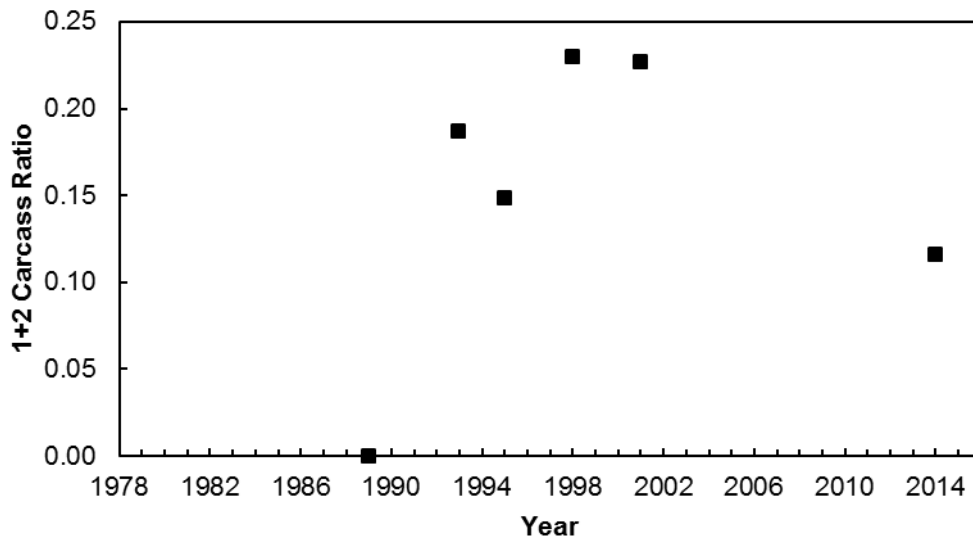


Fig. 5. The 1+2 carcass ratio for elephants in the Zambezi Valley since 1989

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

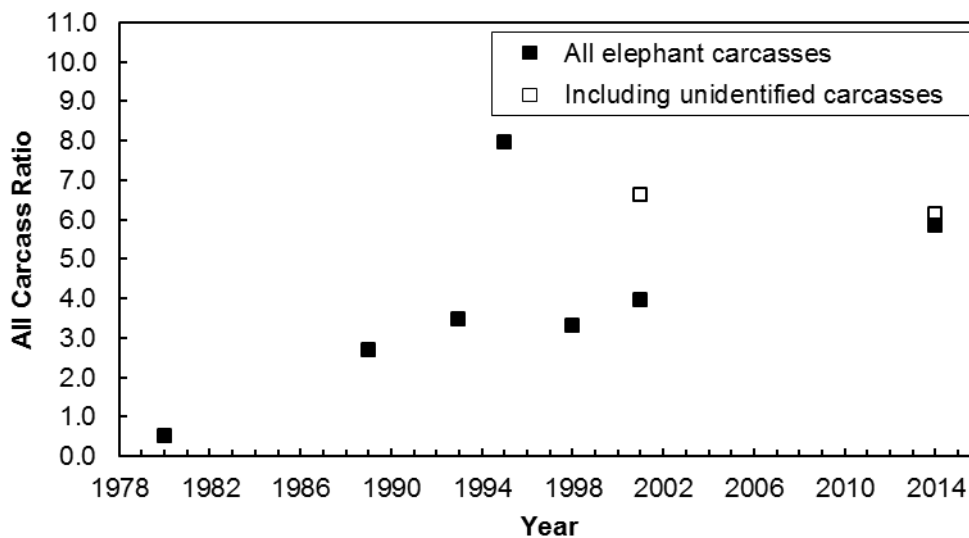


Fig. 6. The all-carcass ratio for elephants in the Zambezi Valley since 1980

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.

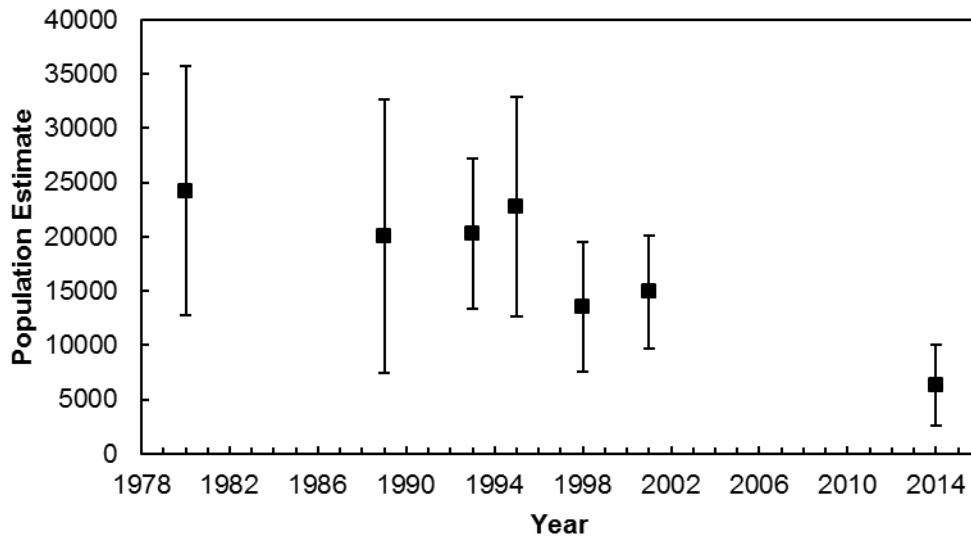


Fig. 7. Number of buffalo estimated to be in the Zambezi Valley since 1980

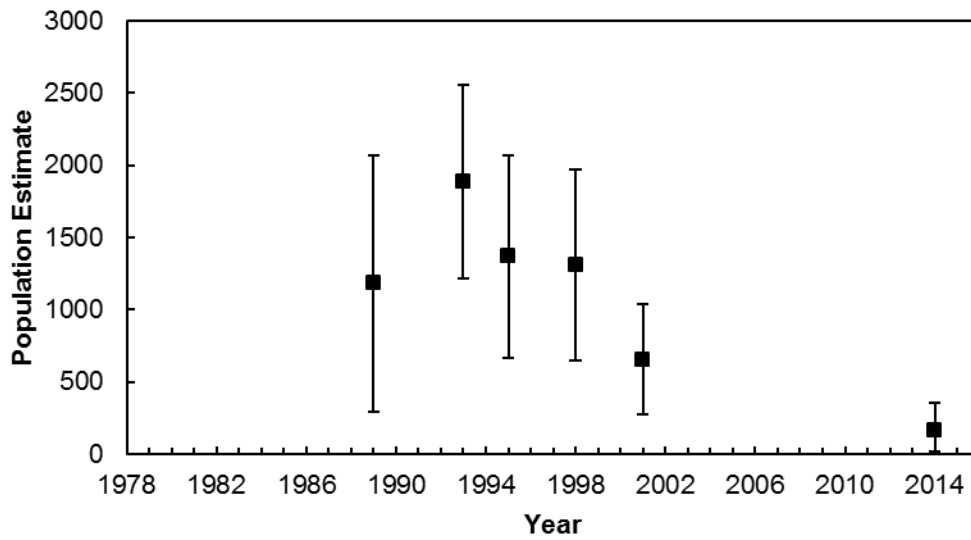


Fig. 8. Number of sable estimated to be in the Zambezi Valley since 1989

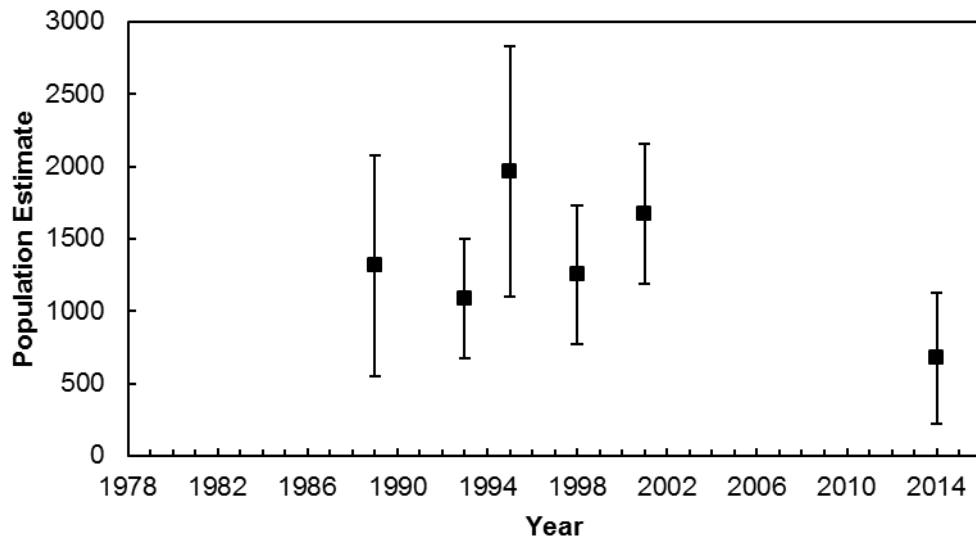


Fig. 9. Number of zebra estimated to be in the Zambezi Valley since 1989

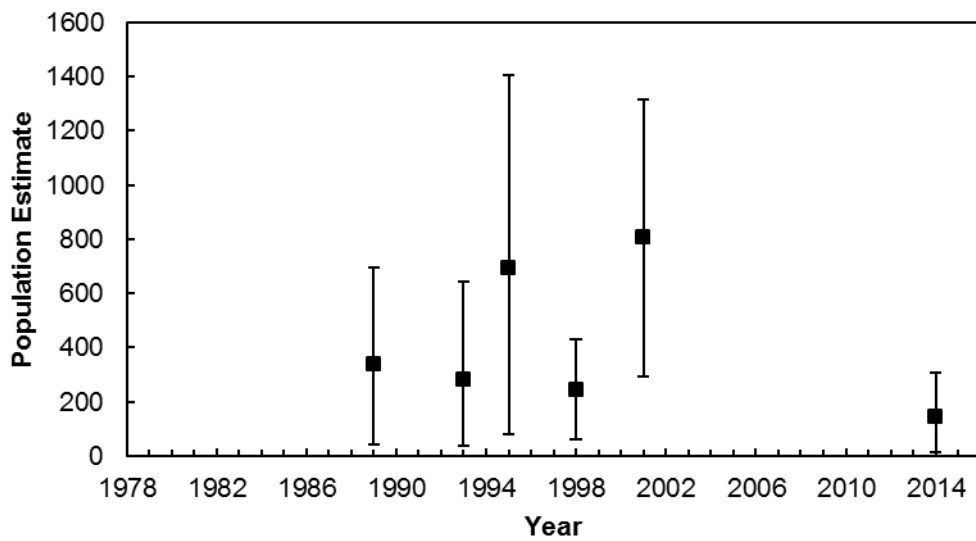


Fig. 10. Number of eland estimated to be in the Zambezi Valley since 1989

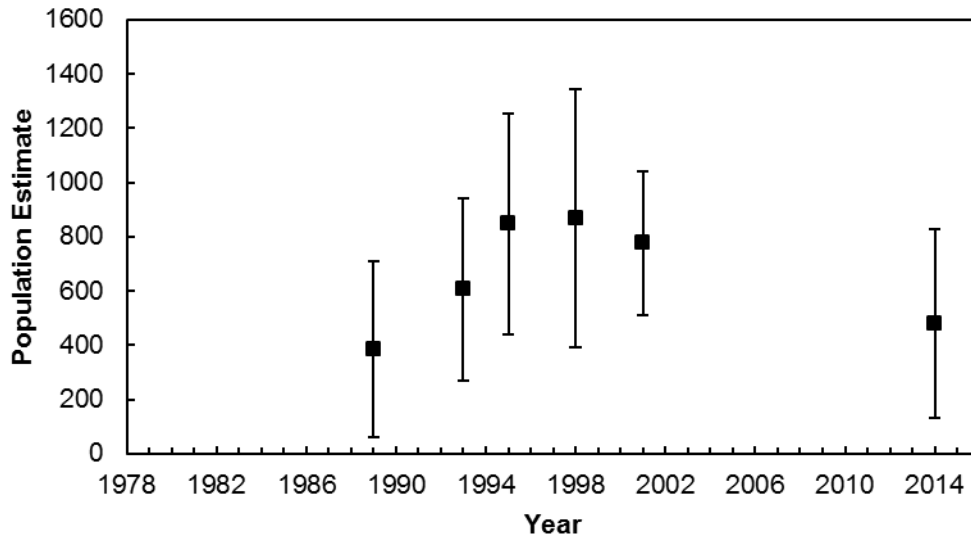


Fig. 11. Number of waterbuck estimated to be in the Zambezi Valley since 1989

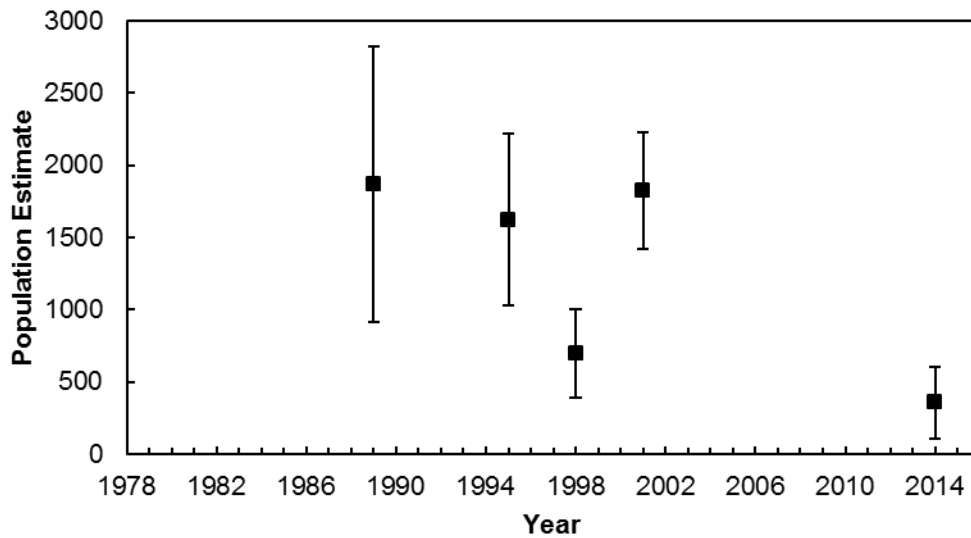


Fig. 12. Number of kudu estimated to be in the Zambezi Valley since 1989

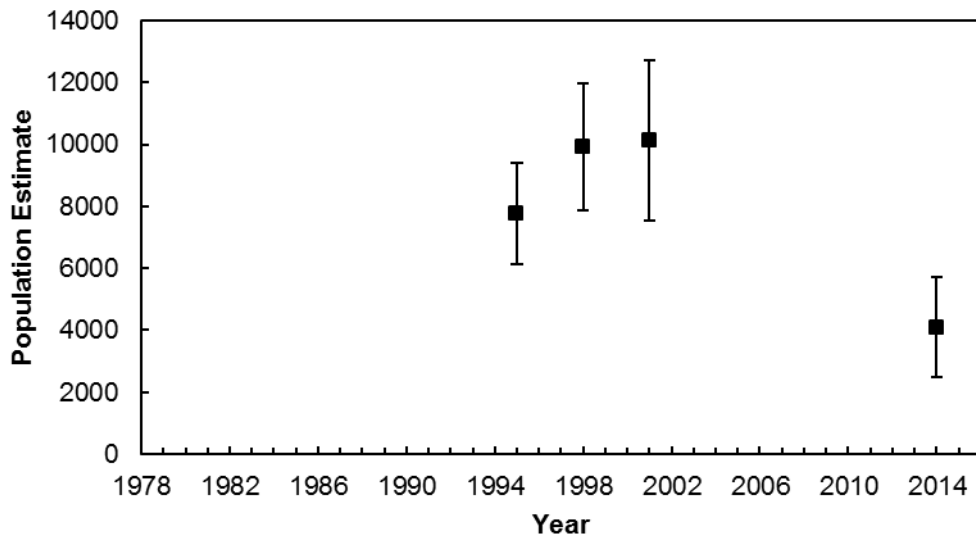


Fig. 13. Number of impala estimated to be in the Zambezi Valley since 1995

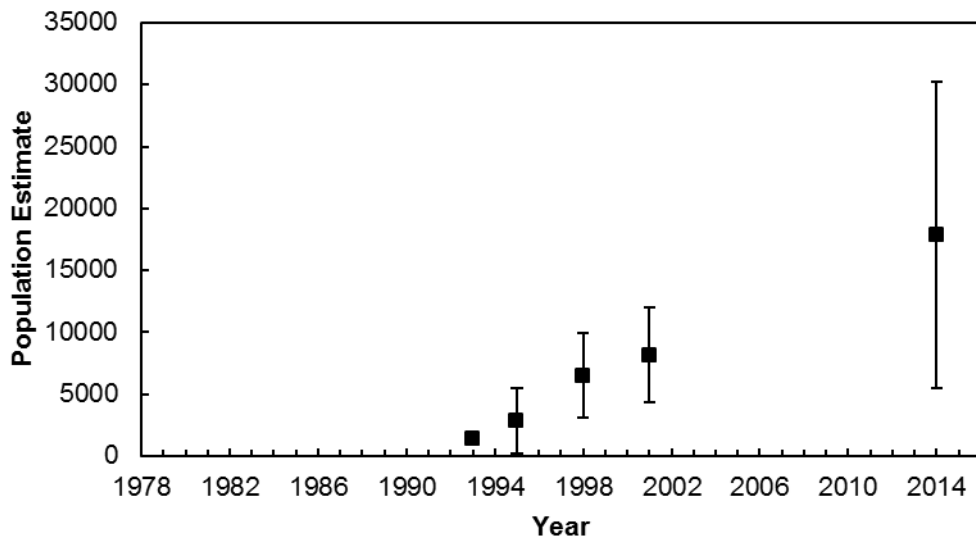


Fig. 14. Number of cattle estimated to be in the Zambezi Valley since 1993

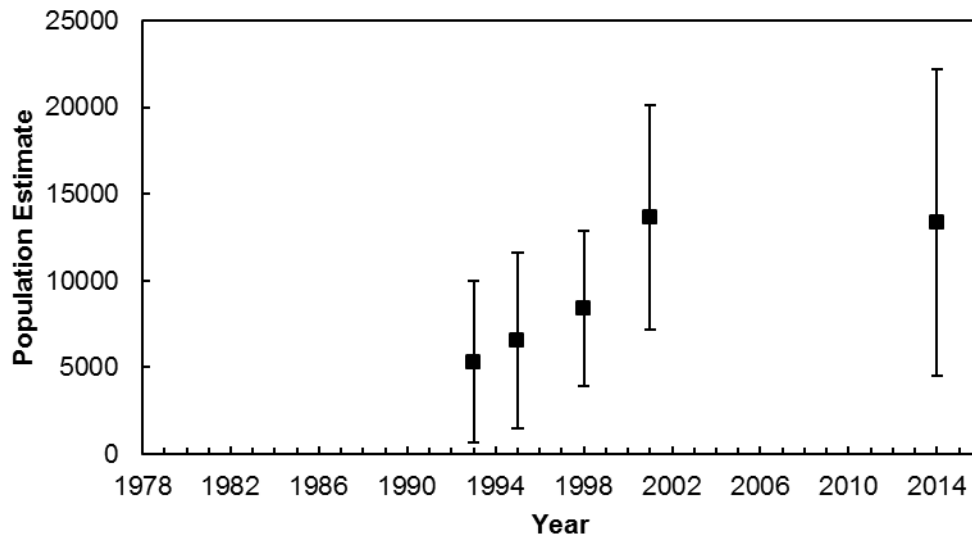


Fig. 15. Number of sheep and goats estimated to be in the Zambezi Valley since 1993

Discussion

Elephants

There were estimated to be 11657 (+/- 2259) elephants in the Zambezi Valley during 2014. This represents a decline of 40 % during the thirteen years between the 2001 and 2014 surveys. While the number of elephants in cow herds declined by 47 % during this period, there was, surprisingly, no decline in the estimated number of elephant bulls.

Elephant Carcasses

The 1+2 carcass ratio of 0.12 % during 2014 was relatively low compared with previous surveys of elephants in the Zambezi Valley (Fig. 5). The 1+2 ratio was 0.23 % during 2001.

The estimated number of all elephant carcasses regardless of age category (724) during 2014 was similar to the number (793) during the 2001 survey, but the all-carcass ratio of 5.8 % during 2014 was greater than that observed during 2001 (3.9 %). However, if it is assumed that all 'unidentified' carcasses were elephant carcasses, then the all-carcass ratio increases to 6.1 % during 2014, which is similar to the ratio of 6.6 % during 2001.

That the number of live elephants declined, without any observed increase in the number of carcasses, or in the carcass ratio, is, at least initially, surprising.

Other Large Herbivores

Study of the temporal variation in the estimated numbers of large herbivores in the Zambezi Valley revealed that most large herbivores, not only elephant, have declined in number in the Zambezi Valley since 2001. For several species (e.g. buffalo and sable) the decline started before 2001. Only for elephant bulls, waterbuck and the two major domestic species of large herbivore (cattle and sheep/goats) has there been no decline in number since 2001.

Encroachment on the Parks and Wild Life Estate

During the block count survey of the southern Charara Safari Area, cultivation and tobacco barns were observed inside the boundary of Charara SA.

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Table 3. Sampling statistics for the 2014 aerial survey of elephants and other large herbivores in the Zambezi Valley

Stratum	Stratum area (km ²)	Transect spacing (km)	Transect orientation (°)	Number of transects/blocks [= 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 / Block	Stratum	Total		
Mana I	319	1.5	0	32	11.0	am 25/08/2014	1.35	2.40	2.88	157	1.15
Mana II	1388	1.8	90	22	8.2	am pm 23, am 31/08/2014	4.18	5.33	6.42	166	1.10
Mana III (Escarpment)	462			6 (6)	16.1	am 01/07/2014	1.47	1.97	2.88	-	1.22
Rifa	615	2.3	90	16	7.0	am 21/08/2014	1.55	2.12	2.28	173	1.07
Hurungwe	1208	1.5	0	39	10.9	am pm 21, am pm 22/08/2014	4.76	6.02	7.07	170	1.08
Hurungwe I	673			10 (10)	19.6	am 29/06/2014	2.28	2.50	3.02	-	1.05
Hurungwe II (Marongora)	524			10 (9)	26.9	am 30/07, am 01/07/2014	2.43	2.85	3.18	-	1.20
Sapi North	316	1.5	0	24	10.8	pm 25, am 27/08/2014	1.27	1.98	3.07	166	1.12
Sapi South	796	3.6	90	11	4.7	am 27, am 28/08/2014	1.36	1.82	2.30	166	1.10
Chewore I	796	3.2	90	13	5.1	am 28/08/2014	1.56	2.12	3.48	162	1.16
Chewore II (Hills)	1058			19 (17)	25.3	am 05, am pm 06, am 07/07/2014	4.78	5.78	7.72	-	1.21
Chewore III	977	3.2	90	12	5.4	am 29/08/2014	1.86	2.47	3.18	171	1.05
Chewore IV (Escarpment)	472			13 (11)	24.9	am 03/07/2014	1.90	2.25	3.23	-	1.24
North Charara	733			8 (8)	18.2	am 28/06/2014	2.43	3.07	3.18	-	1.15
South Charara	929			8 (8)	12.7	am 27/06/2014	2.42	2.83	3.35	-	1.27

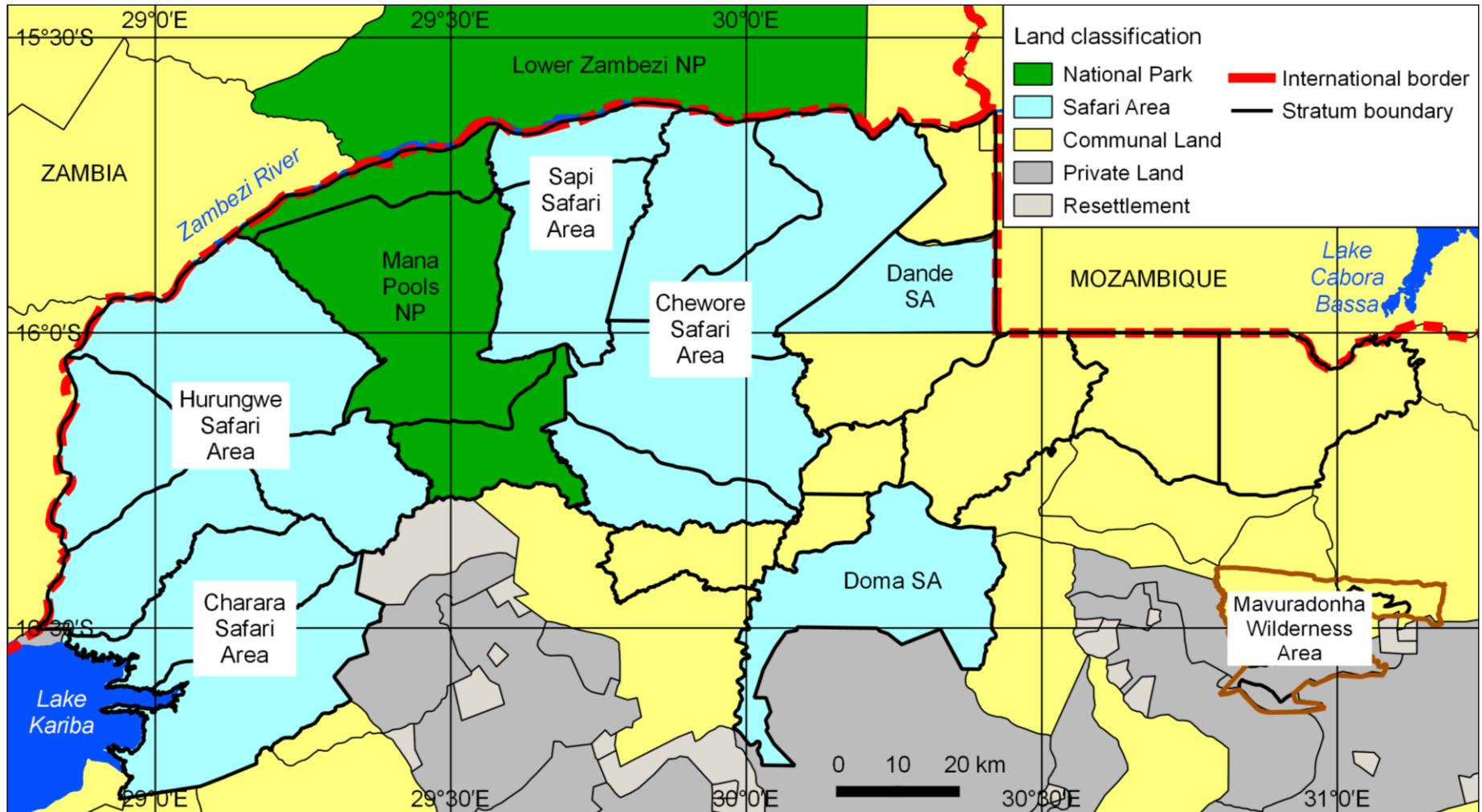
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Stratum	Stratum area (km ²)	Transect spacing (km)	Transect orientation (°)	Number of transects/blocks [= n]	Percent of stratum sampled	Time and date sampled	Flying time (hours) ^a			Mean ground speed (km hour ⁻¹)	Mean search effort (minutes km ⁻²)
							Transect / Block	Stratum	Total		
Doma	991			14 (12)	17.5	am pm 09/07/2014	3.13	3.78	5.12	-	1.26
Dande	991	3.2	0	13	5.2	am 30/08/2014	1.85	2.35	3.20	164	1.08
Chapoto	282	3.7	90	7	4.3	pm 30/08/2014	0.39	0.58	1.32	174	0.96
Chisunga	759	5.7	90	7	3.1	pm 27/08/2014	0.84	1.38	1.92	165	1.07
Kadze West	592	4.6	90	6	3.8	pm 28/08/2014	0.84	1.12	1.73	161	1.12
Kadze East	779	4.6	90	7	3.6	pm 29/08/2014	1.05	1.42	2.32	165	1.11
Kanyurira	207	3	90	5	6.0	am 31/08/2014	0.46	0.67	0.85	161	1.12
Kanyurira Highlands	147			6 (5)	40.7	am 07/07/2014	1.10	1.22	1.93	-	1.28
Mavuradonha high density	273			5 (4)	30.8	am 10/07/2014	1.17	1.30	3.18	-	0.98
Mavuradonha low density	379			6 (5)	25.8	am 10, am 11/07/2014	1.30	1.70	3.40	-	1.03
Mukwiche	337			11 (8)	30.5	am 04/07/2014	1.72	2.15	3.08	-	1.44
Total / Mean	17003				12.6^b		49.44	63.17	85.30	166	1.14

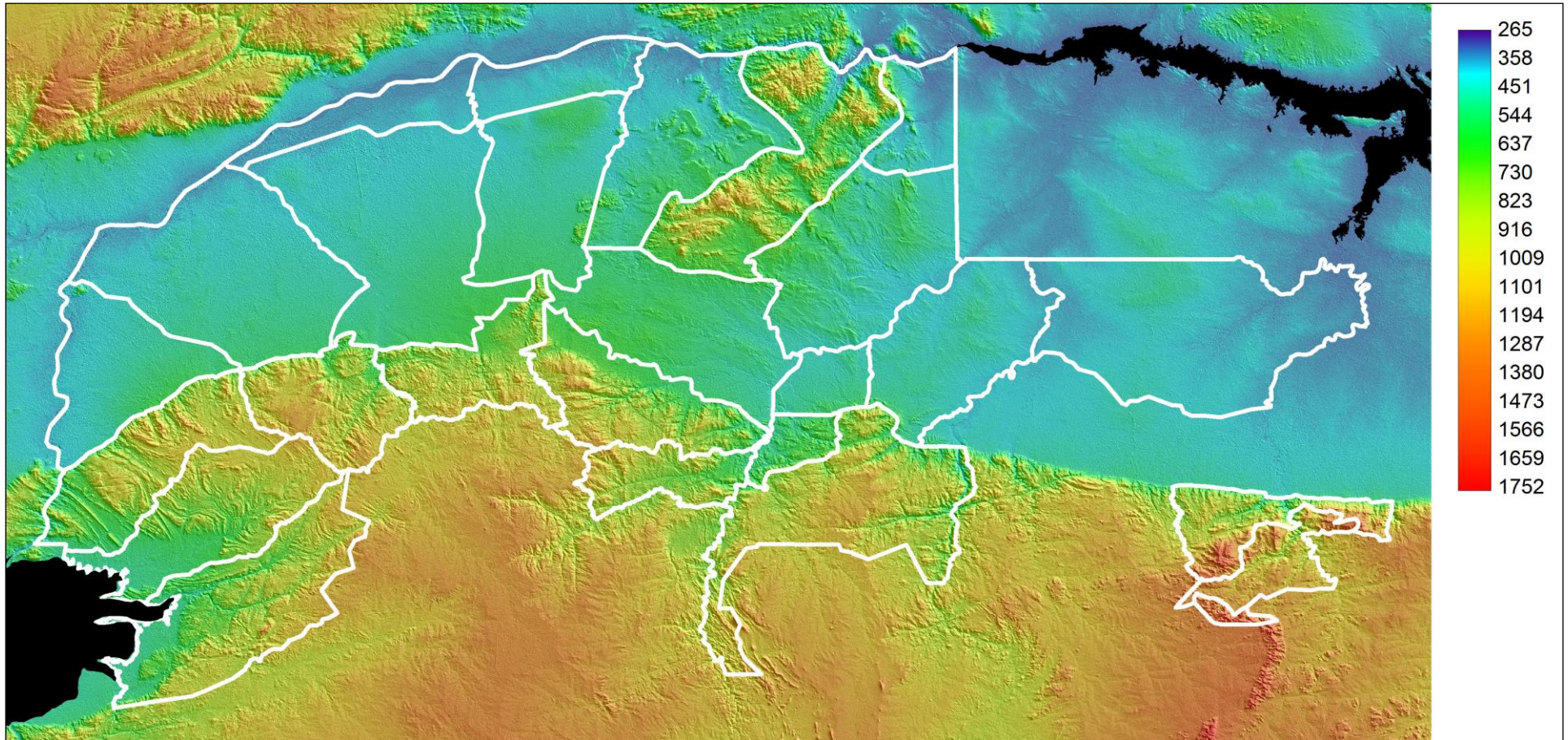
^a Transect /block time is the time spent searching the transects or blocks; stratum time is the transect/block time, plus the time spent travelling between transects/blocks in the same stratum; and total time is the stratum time, plus the time spent travelling between the stratum and the airstrip

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

^c Sampling was with replacement – number in parentheses is the number of blocks searched



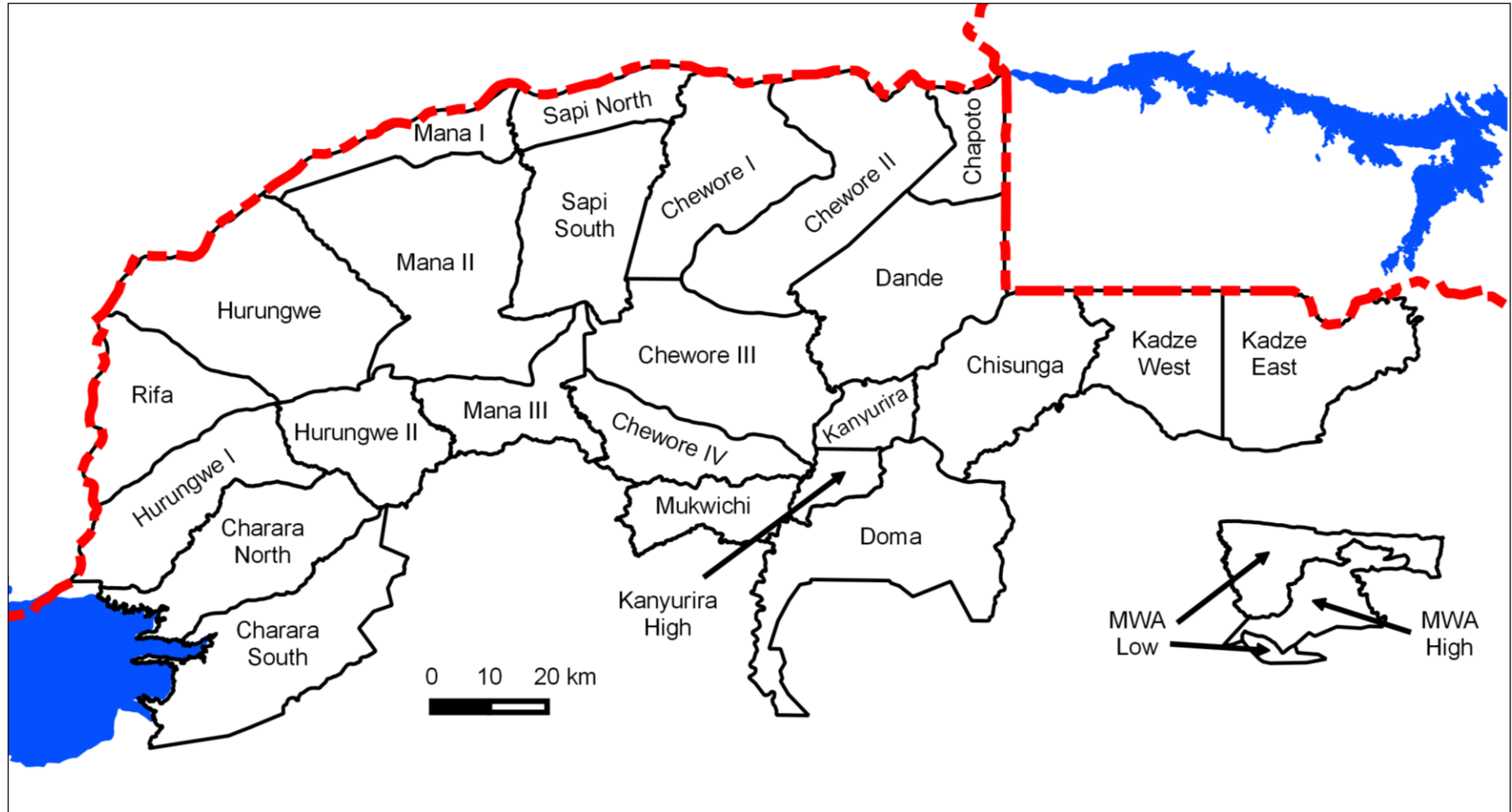
Map 2. Land designation in and around the 2014 Zambezi Valley survey area



Map 3. Altitude in and around the Zambezi Valley survey area

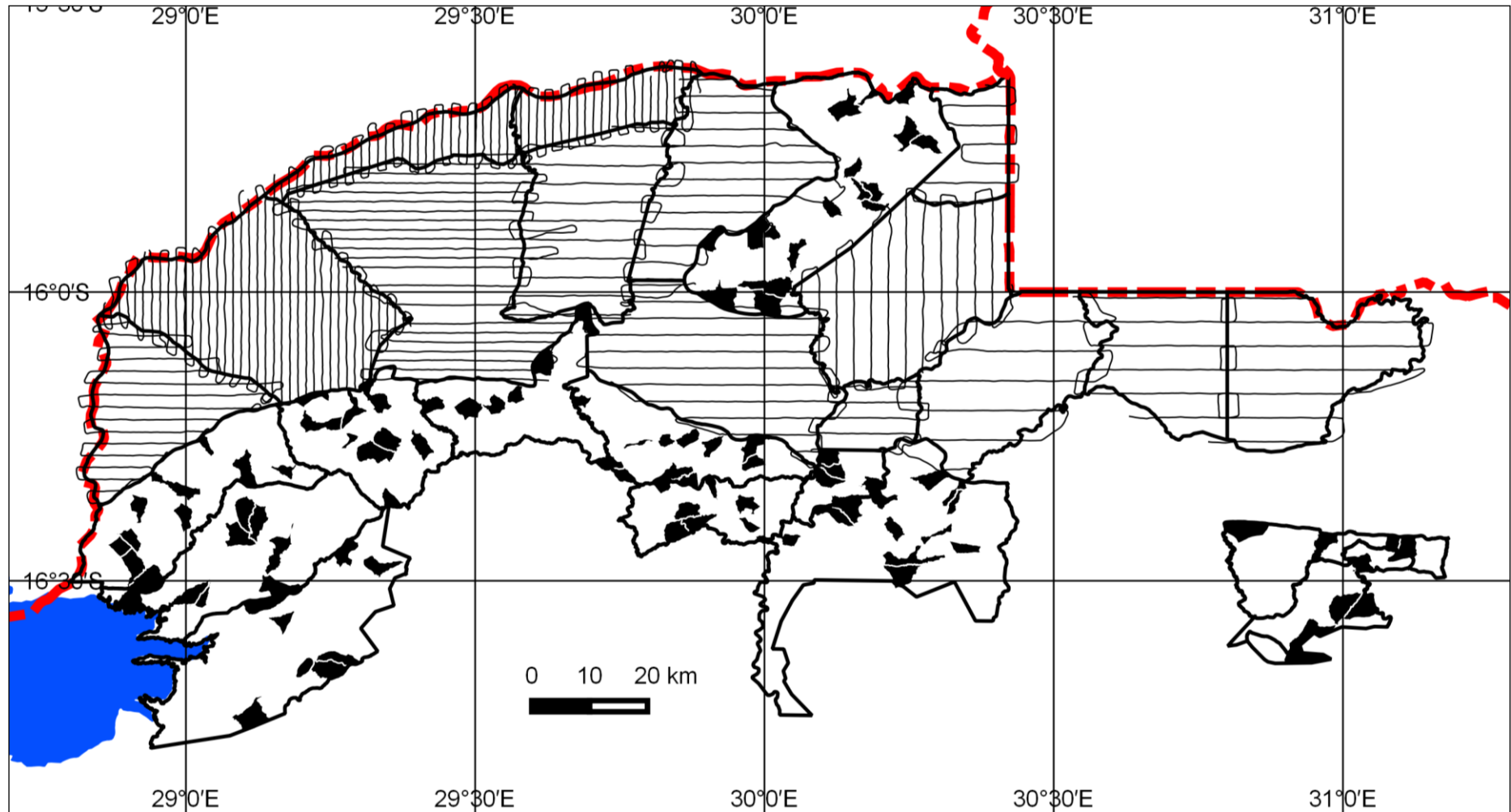
Altitude is in meters. Bold white lines indicate stratum boundaries. Lake Kariba (to the west) and Lake Cabora Bassa in Mozambique (to the east) are shown in black.

ASTER GDEM is a product of METI and NASA.



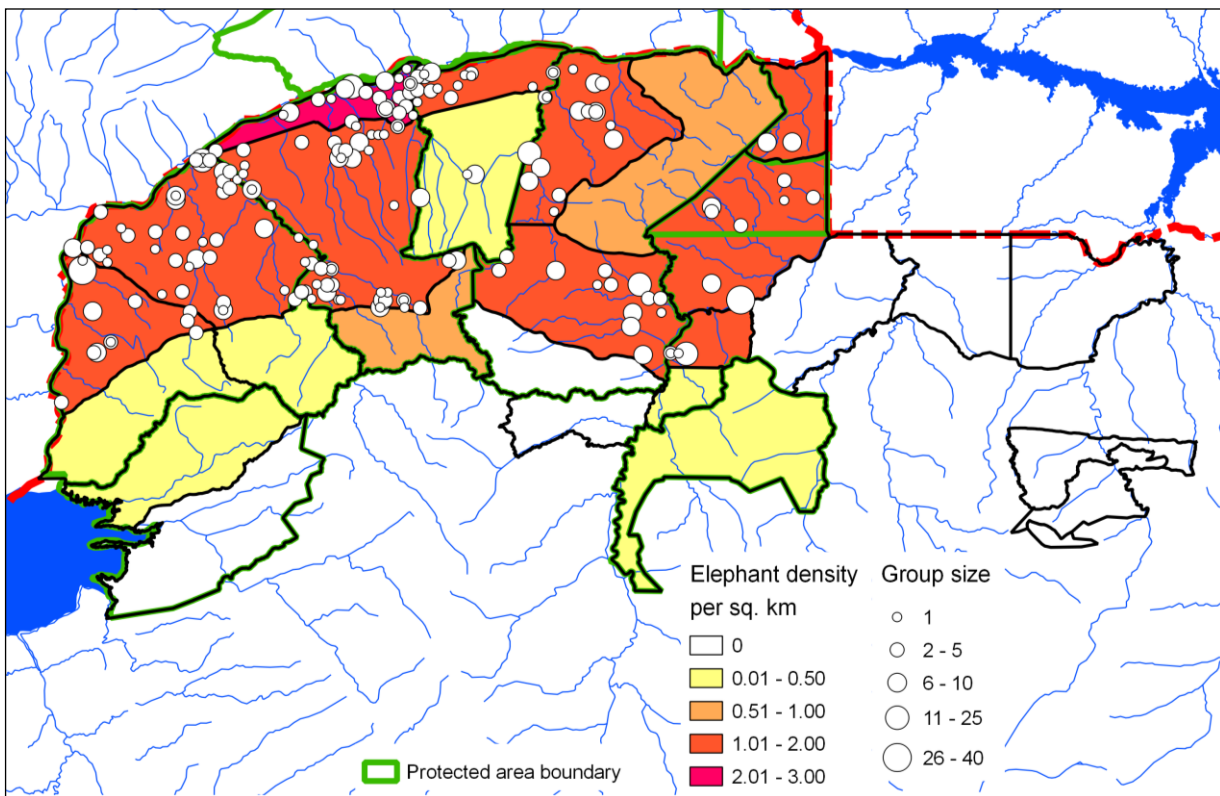
Map 4. Strata used during the Zambezi Valley aerial survey

Bold lines indicate stratum boundaries and labels give stratum names. Lakes Kariba and Cabora Bassa are shown in blue, and the red dashed line indicates the international borders with Zambia and Mozambique..



Map 5. Tracklogs (flight lines) indicating the transects flown during the Zambezi Valley aerial survey

Bold lines indicate stratum boundaries. Thin parallel lines indicate flight lines along the transects. Areas shown in black in the Zambezi Escarpment indicate blocks searched during Block Counts of these strata.



Map 6. Distribution of elephant in the Zambezi Valley during 2014

Colouring indicates the mean density of elephants within each stratum. The dots indicate the locations of elephants seen *within the search strips during transect surveys*, 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 (see Map 5). The green lines indicate the boundaries of the protected areas. The red dashed line indicates the international border.

Sighting locations are not shown for the strata sampled with block counts, because the spatial pattern of sampling in these strata was not systematic.

Table 4. Population estimates and statistics for Elephant in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	888	98	64038	58.1	372	1404	2.78
Mana II	1859	153	122147	39.1	1132	2586	1.34
Mana Escarpment	237	39	14024	128.4	39	542	0.51
Subtotals	2984	290	200209	30.2	2083	3885	1.38
Hurungwe SA							
Rifa	1112	78	241856	94.2	78	2160	1.81
Hurungwe	1356	148	85571	43.7	764	1948	1.12
Hurungwe I	85	19	4131	170.9	19	230	0.13
Hurungwe II Marongora	145	46	7179	132.6	46	336	0.28
Subtotals	2698	291	338737	44.3	1503	3892	0.89
Sapi SA							
Sapi North	428	46	16988	63.0	158	698	1.35
Sapi South	150	7	15962	187.7	7	431	0.19
Subtotals	578	53	32950	64.3	206	950	0.52
Chewore SA							
Chewore I	1491	76	115404	49.6	751	2231	1.87
Chewore II Hills	594	174	25075	56.0	261	927	0.56
Chewore III	1218	66	72897	48.8	624	1812	1.25
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	3303	316	213376	28.7	2355	4251	1.00
Charara SA							
North Charara	36	7	577	156.3	7	93	0.05
South Charara	0	0	0	0.0	0	0	0
Subtotals	36	7	577	156.3	7	93	0.02
Doma SA							
Doma	153	24	7992	125.8	24	347	0.15

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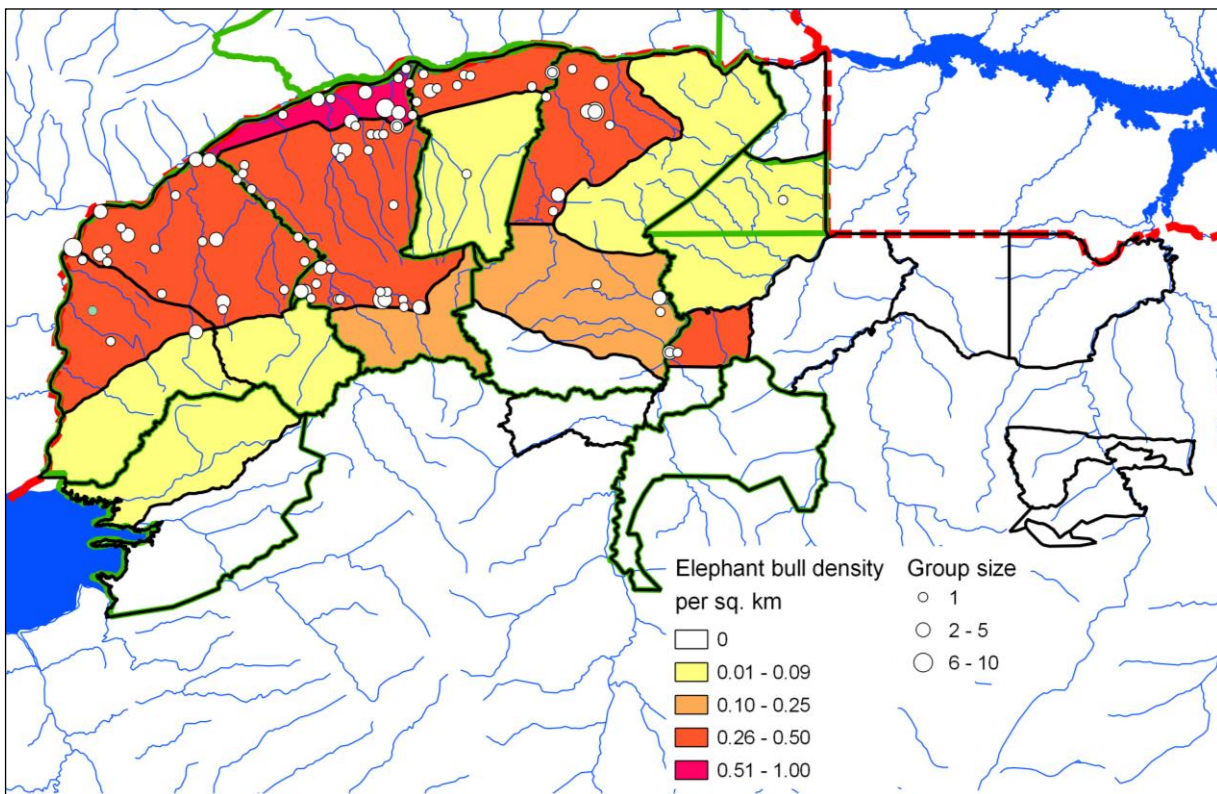
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Communal Lands							
Guruve District							
Dande	1082	56	320629	114.0	56	2316	1.09
Chapoto	417	18	100079	185.6	18	1191	1.48
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	348	21	77768	222.5	21	1122	1.68
Kanyurira Highlands	57	18	398	89.7	18	108	0.39
Subtotals	1904	113	498874	77.1	435	3373	0.51
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	11657	1094	1292716	19.4	9398	13915	0.69

Table 5. Population estimates and statistics for Elephant Bulls in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	299	33	17883	91.2	33	572	0.94
Mana II	644	53	39753	64.4	229	1059	0.46
Mana Escarpment	105	19	4842	170.9	19	284	£0.23
Subtotals	1048	105	62478	48.1	544	1552	0.48
Hurungwe SA							
Rifa	200	14	16196	135.9	14	471	0.32
Hurungwe	449	49	16687	58.2	188	710	0.37
Hurungwe I	27	3	706	226.2	3	87	0.04
Hurungwe II Marongora	30	7	169	99.0	7	59	0.06
Subtotals	705	73	33758	52.5	335	1075	0.23
Sapi SA							
Sapi North	121	13	1199	59.3	49	192	0.38
Sapi South	21	1	431	215.6	1	68	0.03
Subtotals	142	14	1631	57.8	60	225	0.13
Chewore SA							
Chewore I	373	19	36552	111.8	19	789	0.47
Chewore II Hills	59	10	1134	119.3	10	130	0.06
Chewore III	111	6	4199	128.8	6	253	0.11
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	543	35	41885	80.4	106	979	0.16
Charara SA							
North Charara	36	7	577	156.3	7	93	0.05
South Charara	0	0	0	0.0	0	0	0
Subtotals	36	7	577	156.3	7	93	0.02
Doma SA							
Doma	0	0	0	0.0	0	0	0

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Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	19	1	331	205.0	1	59	0.02
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	66	4	4080	267.0	4	244	0.32
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	86	5	4410	215.1	5	270	0.02
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	2560	239	144739	29.5	1804	3316	0.15

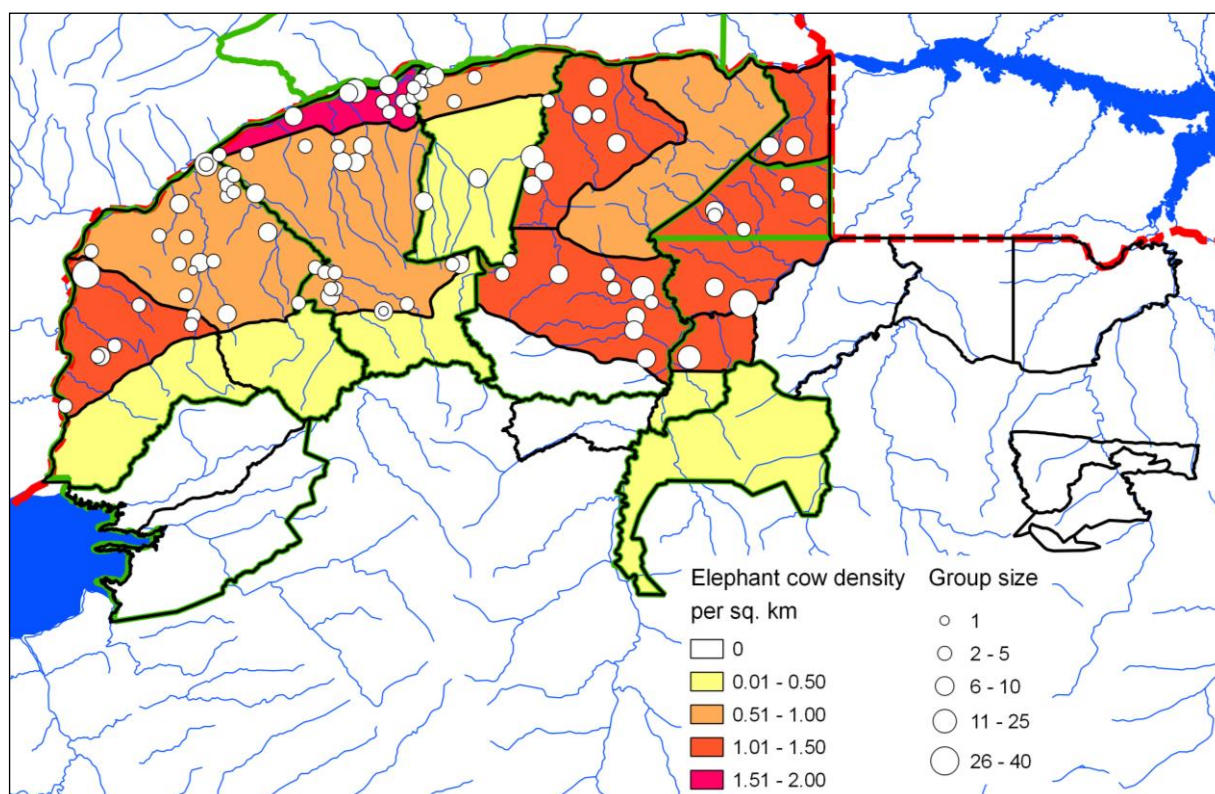


Map 7. Distribution of elephant bulls in the Zambezi Valley during 2014

Table 6. Population estimates and statistics for Elephant Cows in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	589	65	46155	74.3	151	1028	1.85
Mana II	1215	100	82394	49.1	618	1812	0.88
Mana Escarpment	132	20	9182	186.0	20	379	0.29
Subtotals	1937	185	137731	38.6	1190	2684	0.89
Hurungwe SA							
Rifa	912	64	225661	110.9	64	1925	1.48
Hurungwe	907	99	68884	58.6	376	1438	0.75
Hurungwe I	59	16	3425	226.2	16	191	0.09
Hurungwe II Marongora	115	39	7010	164.9	39	304	0.22
Subtotals	1993	218	304980	57.0	858	3128	0.66
Sapi SA							
Sapi North	307	33	15788	84.8	47	567	0.97
Sapi South	129	6	15531	215.6	6	406	0.16
Subtotals	435	39	31319	83.3	73	798	0.39
Chewore SA							
Chewore I	1118	57	78853	54.7	506	1730	1.4
Chewore II Hills	535	164	23941	60.8	209	860	0.51
Chewore III	1107	60	68697	52.1	531	1684	1.13
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	2760	281	171491	30.6	1914	3605	0.84
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Doma SA							
Doma	153	24	7992	125.8	24	347	0.15

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	1063	55	320298	116.0	55	2296	1.07
Chapoto	417	18	100079	185.8	18	1191	1.48
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	282	17	73688	267.0	17	1036	1.36
Kanyurira Highlands	57	18	398	89.7	18	108	0.39
Subtotals	1819	108	494464	80.4	357	3281	0.48
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	9098	855	1147977	23.4	6965	11231	0.54



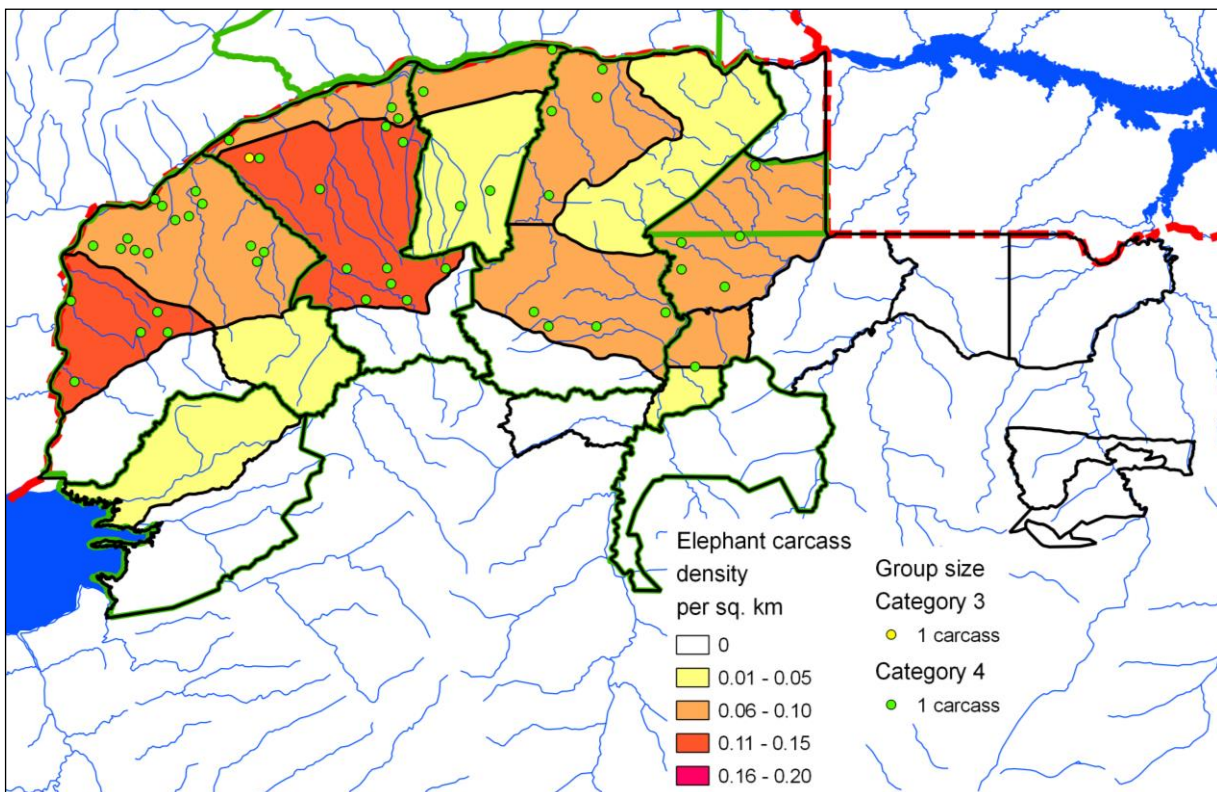
Map 8. Distribution of elephant cows in the Zambezi Valley during 2014

Table 7. Population estimates and statistics for Elephant Carcass 2 in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	0	0	0	0.0	0	0	0
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	0	0	0	0.0	0	0	0
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Charara SA							
North Charara	13	1	182	236.5	1	45	0.02
South Charara	0	0	0	0.0	0	0	0
Subtotals	13	1	182	236.5	1	45	0.01
Doma SA							
Doma	0	0	0	0.0	0	0	0

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Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	13	1	182	236.5	1	45	0.001



Map 9. Distribution of elephant carcasses in the Zambezi Valley during 2014

Table 8. Population estimates and statistics for Elephant Carcass 3 in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	0	0	0	0.0	0	0	0
Mana II	12	1	137	200.1	1	36	0.01
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	12	1	137	200.1	1	36	0.01
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	0	0	0	0.0	0	0	0
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Charara SA							
North Charara	5	1	29	236.5	1	18	0.007
South Charara	0	0	0	0.0	0	0	0
Subtotals	5	1	29	236.5	1	18	0.003
Doma SA							
Doma	0	0	0	0.0	0	0	0

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Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	18	2	166	150.6	2	44	0.001

Table 9. Population estimates and statistics for Elephant Carcass 4 in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	18	2	146	135.7	2	43	0.06
Mana II	134	11	2173	72.5	37	231	0.1
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	152	13	2319	65.6	52	251	0.07
Hurungwe SA							
Rifa	71	5	855	87.4	9	134	0.12
Hurungwe	119	13	621	42.3	69	170	0.10
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	6	1	18	150.8	1	16	0.01
Subtotals	197	19	1494	39.8	118	275	0.07
Sapi SA							
Sapi North	19	2	142	132.5	2	43	0.06
Sapi South	43	2	797	146.5	2	106	0.05
Subtotals	62	4	939	107.6	4	128	0.06
Chewore SA							
Chewore I	78	4	1070	90.9	7	150	0.10
Chewore II Hills	8	2	34	158.8	2	20	0.007
Chewore III	74	4	1973	132.4	4	172	0.08
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	160	10	3077	72.1	45	275	0.05
Charara SA							
North Charara	5	1	29	236.5	1	18	0.007
South Charara	0	0	0	0.0	0	0	0
Subtotals	5	1	29	236.5	1	18	0.003
Doma SA							
Doma	0	0	0	0.0	0	0	0

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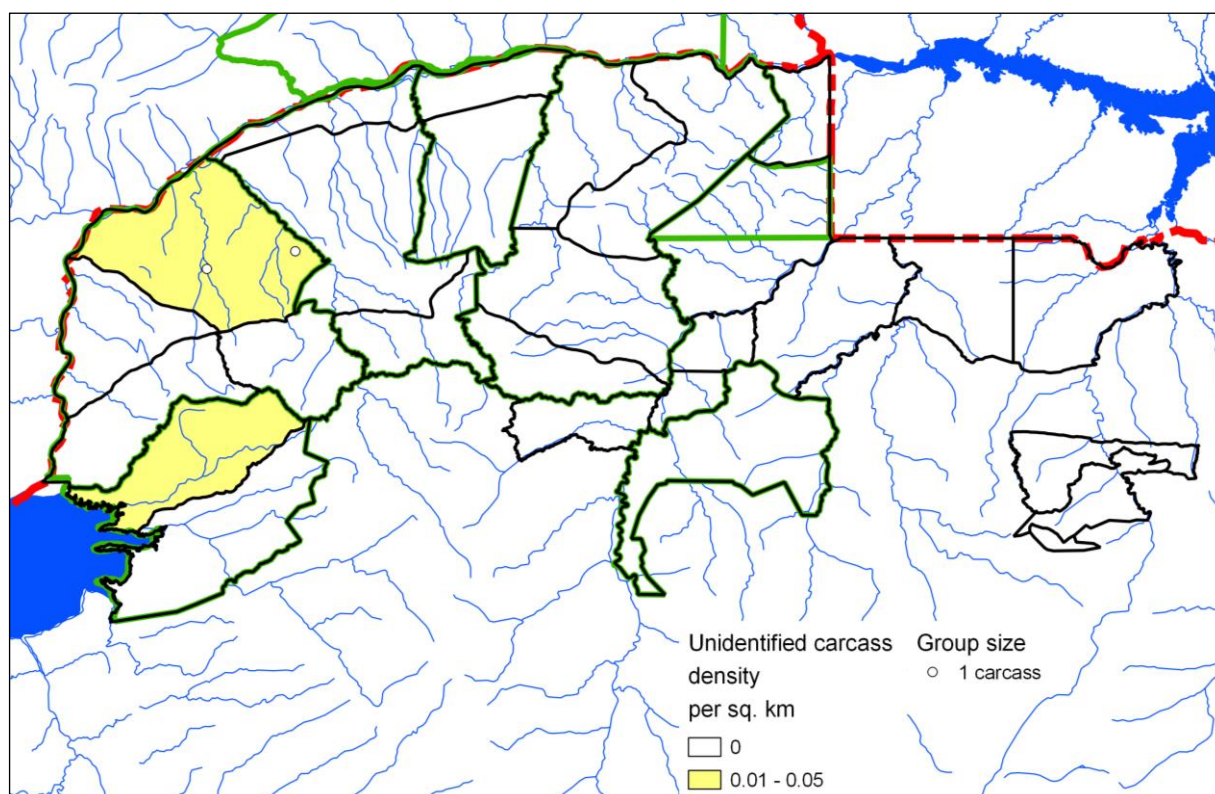
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Communal Lands							
Guruve District							
Dande	97	5	1496	87.2	12	181	0.10
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	17	1	321	299.6	1	66	0.08
Kanyurira Highlands	4	2	15	257.1	2	14	0.03
Subtotals	117	8	1832	77.9	26	208	0.03
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	693	55	9689	28.2	497	888	0.04

Table 10. Population estimates and statistics for Unidentified Carcasses in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	0	0	0	0.0	0	0	0
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	18	2	142	131.5	2	42	0.02
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	18	2	142	131.5	2	42	0.01
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Charara SA							
North Charara	19	2	190	172.7	2	51	0.03
South Charara	0	0	0	0.0	0	0	0
Subtotals	19	2	190	172.7	2	51	0.01
Doma SA							
Doma	0	0	0	0.0	0	0	0

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	37	4	332	102.5	4	75	0.002



Map 10. Distribution of unidentified carcasses in the Zambezi Valley during 2014

Table 11. Elephant carcass ratios in the Zambezi Valley

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)
Parks & Wild Life Estate			
Mana Pools NP			
Mana I	0.00	2.0	2.0
Mana II	0.00	7.3	7.3
Mana Escarpment	0.00	0.0	0.0
Entire NP	0.00	5.2	5.2
Hurungwe SA			
Rifa	0.00	6.0	6.0
Hurungwe	0.00	8.1	9.2
Hurungwe I	0.00	0.0	0.0
Hurungwe II Marongora	0.00	4.2	4.2
Entire SA	0.00	6.8	7.4
Sapi SA			
Sapi North	0.00	4.2	4.2
Sapi South	0.00	22.3	22.3
Entire SA	0.00	9.6	9.6
Chewore SA			
Chewore I	0.00	5.0	5.0
Chewore II Hills	0.00	1.3	1.3
Chewore III	0.00	5.7	5.7
Chewore IV Escarpment	-	-	-
Entire SA	0.00	4.6	4.6
Charara SA			
North Charara	27.05	40.0	54.3
South Charara	-	-	-
Entire SA	27.05	40.0	54.3
Doma SA			
Doma	0.00	0.0	0.0
Parks & Wild Life Estate	0.14	5.9	6.2

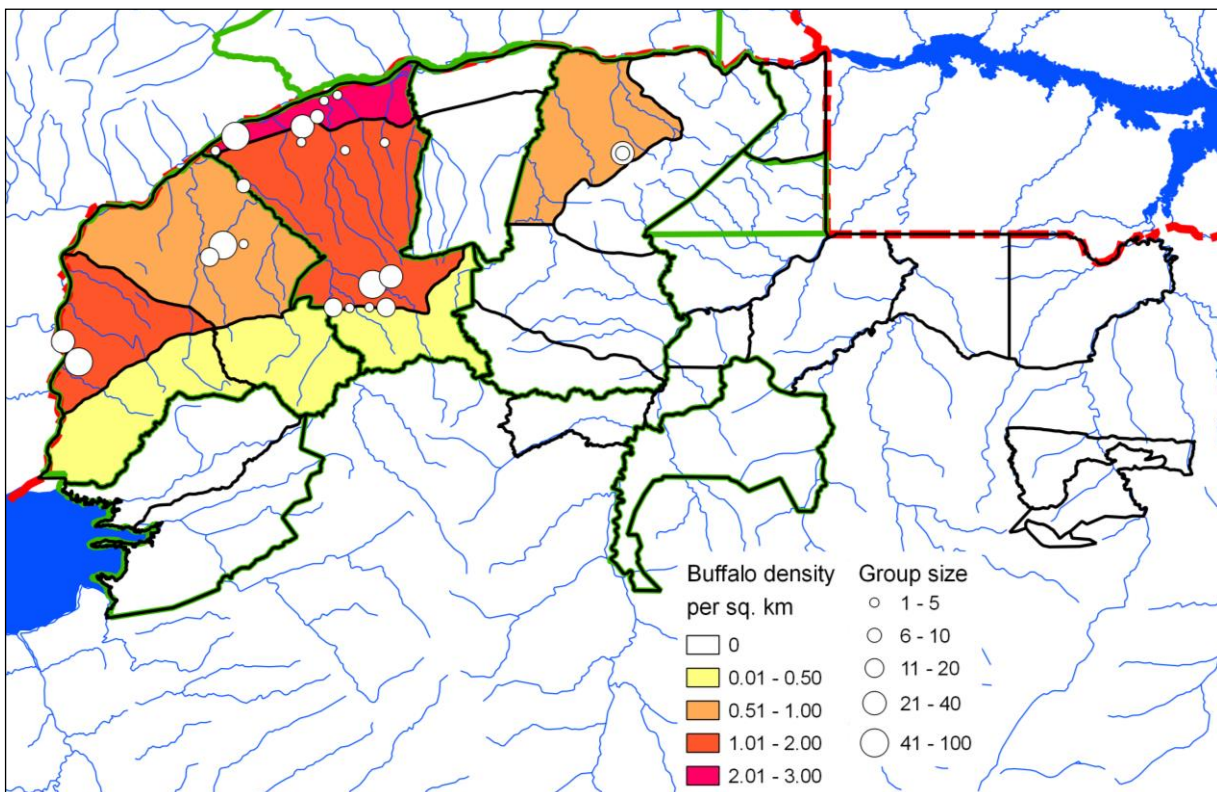
Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

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)
Communal Lands			
Guruve District			
Dande	0.00	8.2	8.2
Chapoto	0.00	0.0	0.0
Chisunga	-	-	-
Kadze West	-	-	-
Kadze East	-	-	-
Kanyurira	0.00	4.6	4.6
Kanyurira Highlands	0.00	6.3	6.3
Guruve District CL	0.00	5.8	5.8
Other Districts			
MWA high density	-	-	-
MWA low density	-	-	-
Mukwiche	-	-	-
Other CL	-	-	-
All Communal Lands	0.00	5.8	5.8
Zambezi Valley	0.12	5.8	6.1

Table 12. Population estimates and statistics for Buffalo in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	907	100	560632	168.4	100	2434	2.84
Mana II	2528	208	1802575	110.5	208	5320	1.82
Mana Escarpment	30	5	905	257.1	5	107	0.07
Subtotals	3465	313	2364112	90.3	337	6593	1.60
Hurungwe SA							
Rifa	1069	75	495065	140.2	75	2569	1.74
Hurungwe	687	75	189360	128.2	75	1568	0.57
Hurungwe I	261	80	68309	226.2	80	853	0.39
Hurungwe II Marongora	141	50	19842	226.2	50	459	0.27
Subtotals	2159	280	772575	82.8	371	3947	0.71
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Chewore SA							
Chewore I	706	36	438872	204.5	36	2149	0.89
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	706	36	438872	204.5	36	2149	0.21
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Doma SA							
Doma	0	0	0	0.0	0	0	0

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	6330	629	3575559	59.7	2552	10107	0.37

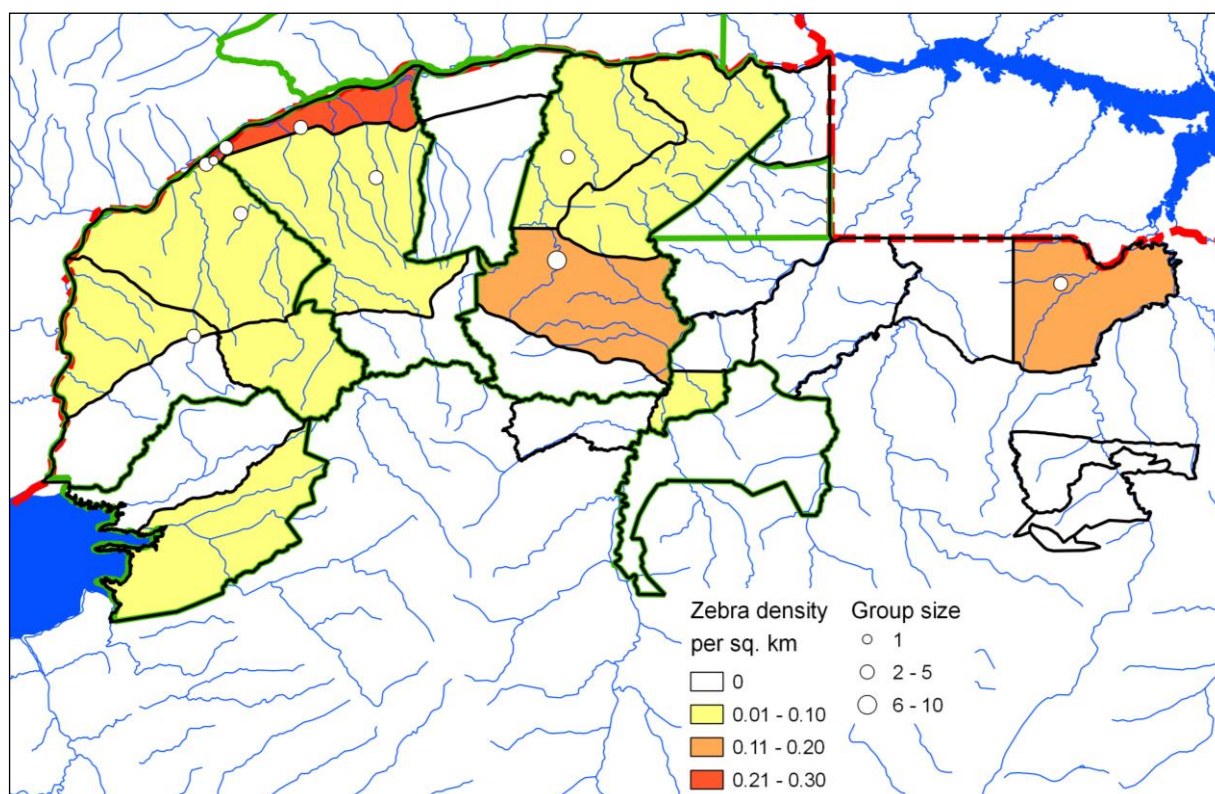


Map 11. Distribution of buffalo in the Zambezi Valley during 2014

Table 13. Population estimates and statistics for Zebra in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	73	8	2475	139.9	8	174	0.23
Mana II	49	4	2212	201.3	4	146	0.04
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	121	12	4688	113.4	12	259	0.06
Hurungwe SA							
Rifa	29	2	672	193.8	2	84	0.05
Hurungwe	46	5	577	106.1	5	94	0.04
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	35	8	618	160.9	8	91	0.07
Subtotals	109	15	1867	79.8	22	196	0.04
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Chewore SA							
Chewore I	78	4	5418	204.5	4	239	0.10
Chewore II Hills	53	12	2858	210.1	12	166	0.05
Chewore III	148	8	18586	203.2	8	448	0.15
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	280	24	26862	121.9	24	620	0.08
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	17	2	287	236.5	2	57	0.02
Subtotals	17	2	287	236.5	2	57	0.01
Doma SA							
Doma	0	0	0	0.0	0	0	0

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	138	5	15073	217.5	5	439	0.18
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	10	5	93	257.1	5	34	0.07
Subtotals	148	10	15166	203.9	10	449	0.04
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	675	63	48870	66.7	224	1125	0.04

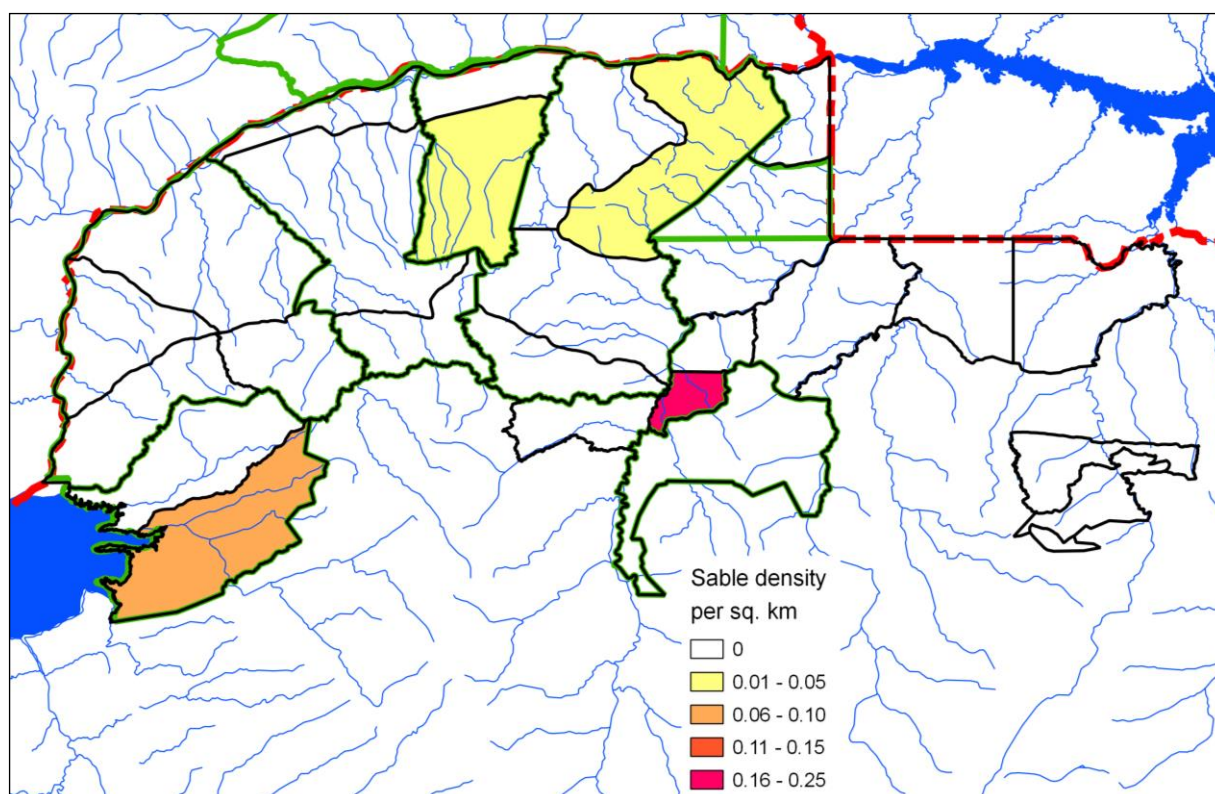


Map 12. Distribution of zebra in the Zambezi Valley during 2014

Table 14. Population estimates and statistics for Sable in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	0	0	0	0.0	0	0	0
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	0	0	0	0.0	0	0	0
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	43	2	1645	210.5	2	133	0.05
Subtotals	43	2	1645	210.5	2	133	0.04
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	6	1	37	210.1	1	19	0.006
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	6	1	37	210.1	1	19	0.002
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	75	9	5573	236.5	9	251	0.08
Subtotals	75	9	5573	236.5	9	251	0.04
Doma SA							
Doma	0	0	0	0.0	0	0	0

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	37	7	556	162.6	7	98	0.25
Subtotals	37	7	556	162.6	7	98	0.01
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	161	19	7811	119.6	19	354	0.01

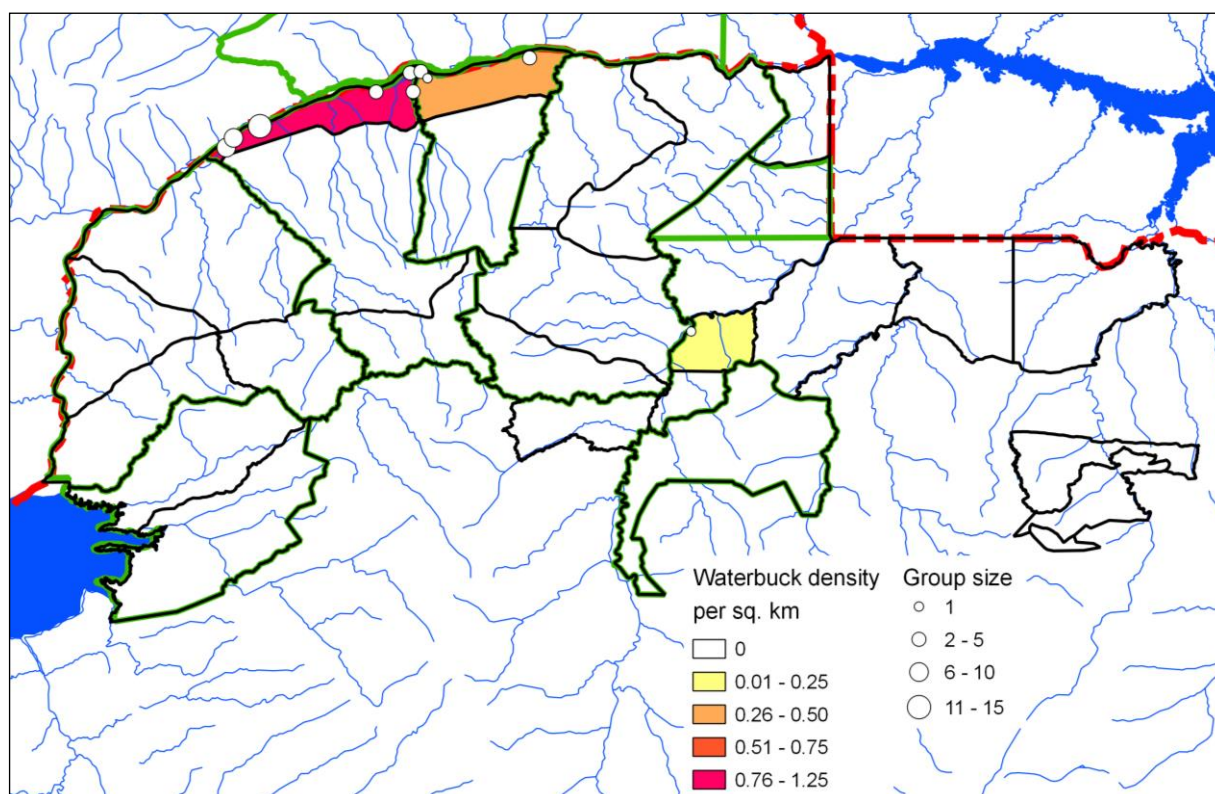


Map 13. Distribution of sable in the Zambezi Valley during 2014

Table 15. Population estimates and statistics for Waterbuck in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	381	42	26655	87.4	48	714	1.19
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	381	42	26655	87.4	48	714	0.18
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	0	0	0	0.0	0	0	0
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Sapi SA							
Sapi North	84	9	2365	120.3	9	184	0.26
Sapi South	0	0	0	0.0	0	0	0
Subtotals	84	9	2365	120.3	9	184	0.08
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Doma SA							
Doma	0	0	0	0.0	0	0	0

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	17	1	298	288.5	1	64	0.08
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	17	1	298	288.6	1	65	0.004
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	481	52	29318	72.1	134	828	0.03



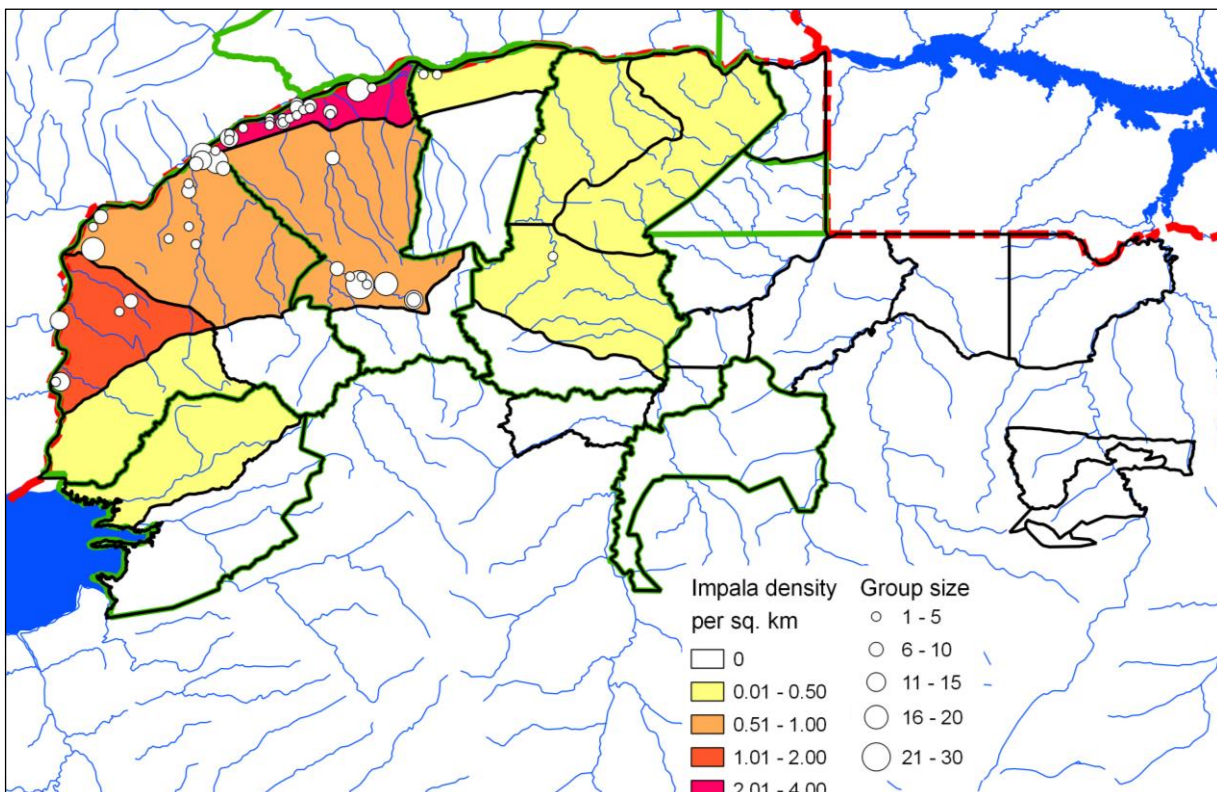
Map 14. Distribution of waterbuck in the Zambezi Valley during 2014

Table 16. Population estimates and statistics for Impala in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	1097	121	129564	66.9	363	1832	3.44
Mana II	1009	83	301584	113.2	83	2151	0.73
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	2106	204	431149	63.1	777	3435	0.97
Hurungwe SA							
Rifa	670	47	110063	105.5	47	1377	1.09
Hurungwe	981	107	104514	66.7	326	1635	0.81
Hurungwe I	48	12	2284	226.2	12	156	0.07
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	1698	166	216861	55.3	759	2638	0.56
Sapi SA							
Sapi North	46	5	916	134.8	5	109	0.15
Sapi South	0	0	0	0.0	0	0	0
Subtotals	46	5	916	134.7	5	109	0.04
Chewore SA							
Chewore I	59	3	2917	200.1	3	177	0.07
Chewore II Hills	157	46	12257	148.1	46	390	0.15
Chewore III	18	1	290	203.2	1	56	0.02
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	234	50	15464	109.1	50	490	0.07
Charara SA							
North Charara	14	3	201	236.5	3	48	0.02
South Charara	0	0	0	0.0	0	0	0
Subtotals	14	3	201	236.5	3	48	0.01
Doma SA							
Doma	0	0	0	0.0	0	0	0

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Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	4099	428	664590	39.6	2475	5724	0.24

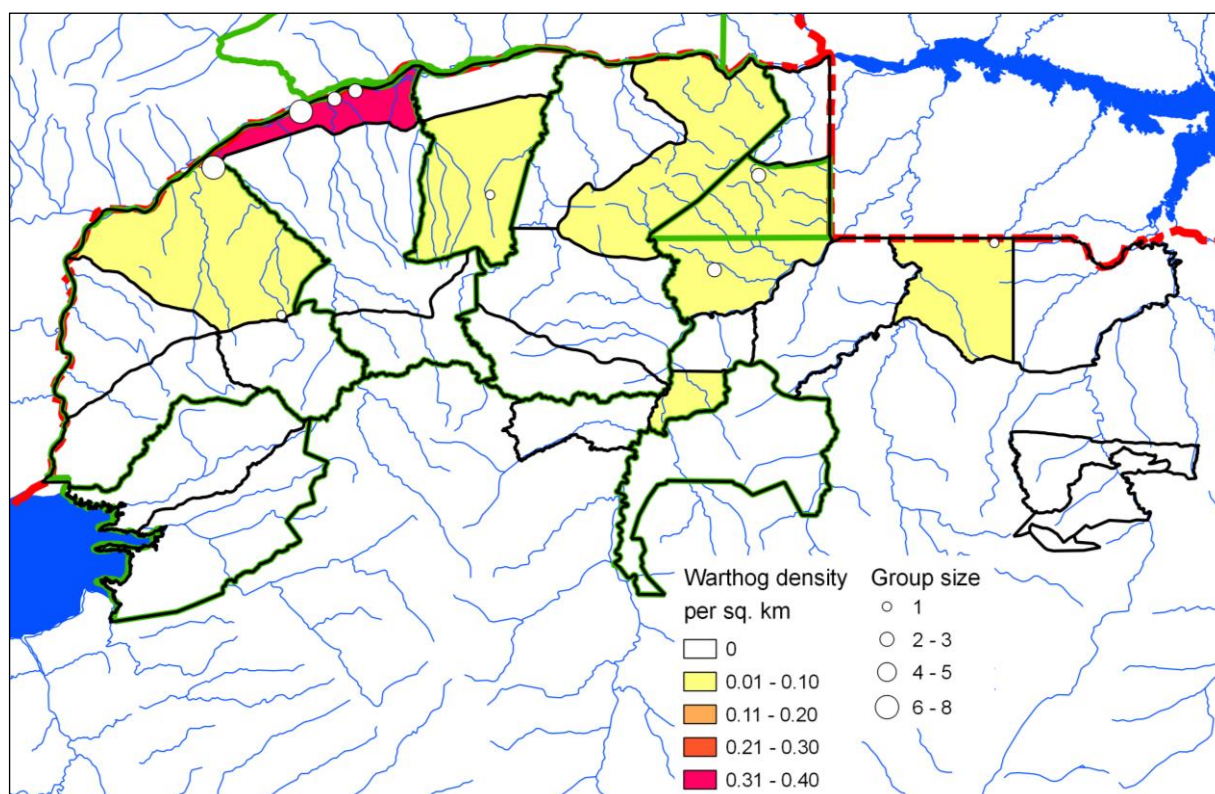


Map 15. Distribution of impala in the Zambezi Valley during 2014

Table 17. Population estimates and statistics for Warthog in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	109	12	3859	116.5	12	236	0.34
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	109	12	3859	116.4	12	236	0.05
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	82	9	4576	166.0	9	219	0.07
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	82	9	4576	166.0	9	219	0.03
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	21	1	435	216.5	1	68	0.03
Subtotals	21	1	435	216.5	1	68	0.02
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	4	2	19	210.1	2	14	0.004
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	4	2	19	210.1	2	14	0.001
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Doma SA							
Doma	0	0	0	0.0	0	0	0

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	97	5	3599	135.3	5	227	0.10
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	26	1	717	261.1	1	95	0.04
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	2	1	5	257.1	1	8	0.01
Subtotals	125	7	4320	111.9	7	265	0.03
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	342	31	13210	66.8	114	571	0.02



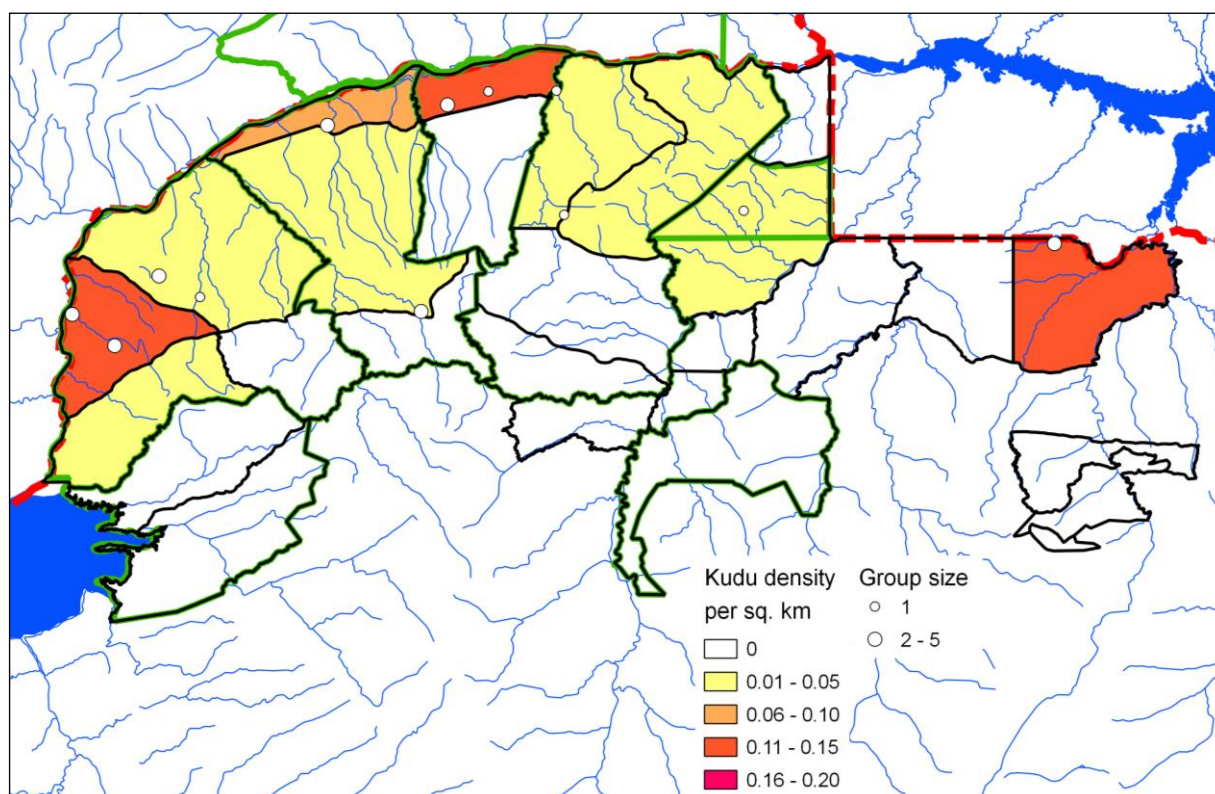
Map 16. Distribution of warthog in the Zambezi Valley during 2014

Table 18. Population estimates and statistics for Kudu in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	18	2	300	194.9	2	53	0.06
Mana II	24	2	591	208.0	2	75	0.02
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	42	4	891	142.1	4	103	0.02
Hurungwe SA							
Rifa	86	6	3190	140.7	6	206	0.14
Hurungwe	27	3	354	138.5	3	66	0.02
Hurungwe I	7	1	43	226.2	1	21	0.01
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	120	10	3587	105.2	10	245	0.04
Sapi SA							
Sapi North	37	4	423	114.5	4	80	0.12
Sapi South	0	0	0	0.0	0	0	0
Subtotals	37	4	423	114.5	4	80	0.03
Chewore SA							
Chewore I	20	1	378	215.9	1	62	0.02
Chewore II Hills	37	7	1378	210.1	7	115	0.04
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	57	8	1756	151.8	8	143	0.02
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Doma SA							
Doma	0	0	0	0.0	0	0	0

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Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	19	1	313	199.4	1	58	0.02
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	83	3	7215	250.8	3	291	0.11
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	102	4	7528	207.7	4	315	0.03
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	358	30	14184	69.2	110	606	0.02

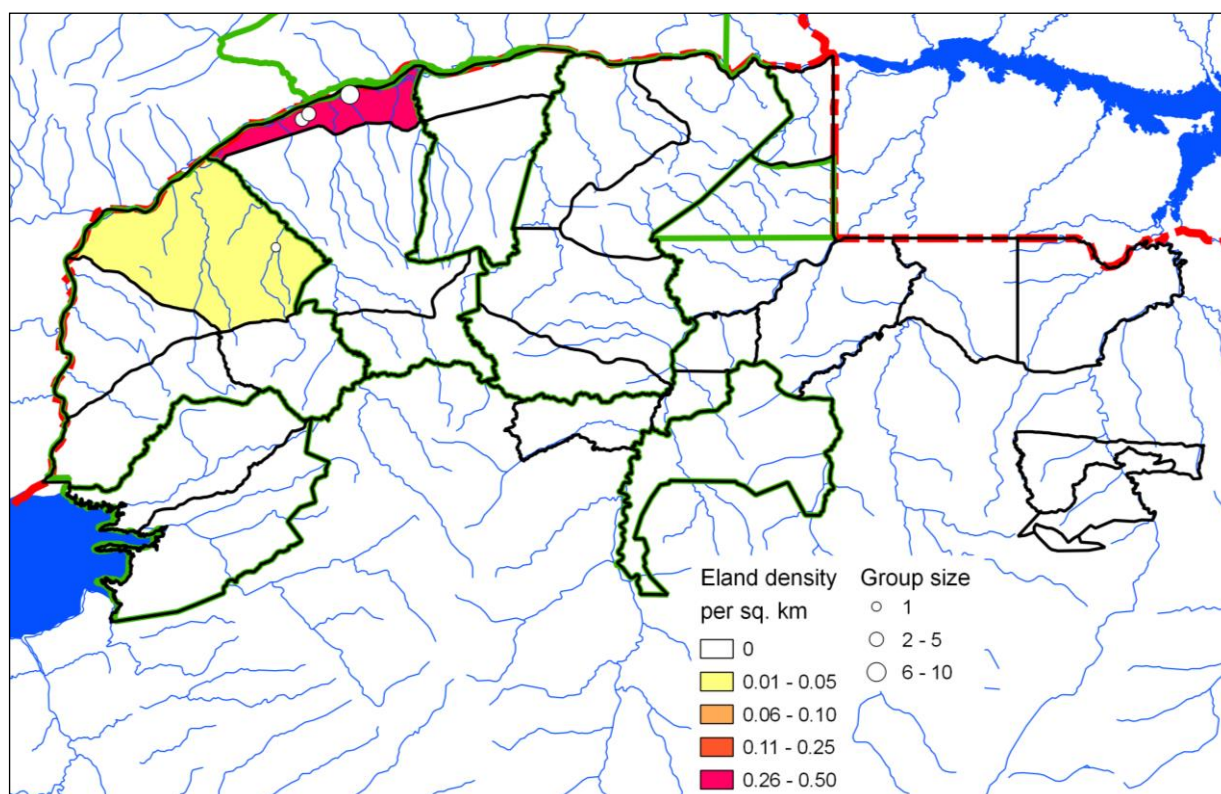


Map 17. Distribution of kudu in the Zambezi Valley during 2014

Table 19. Population estimates and statistics for Eland in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	136	15	6343	119.4	15	299	0.43
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	136	15	6343	119.4	15	298	0.06
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	9	1	74	189.7	1	27	0.008
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	9	1	74	189.7	1	27	0.003
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Doma SA							
Doma	0	0	0	0.0	0	0	0

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Other Districts							
Kanyurira Highlands	0	0	0	0.0	0	0	0
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	145	16	6417	112.5	16	309	0.01

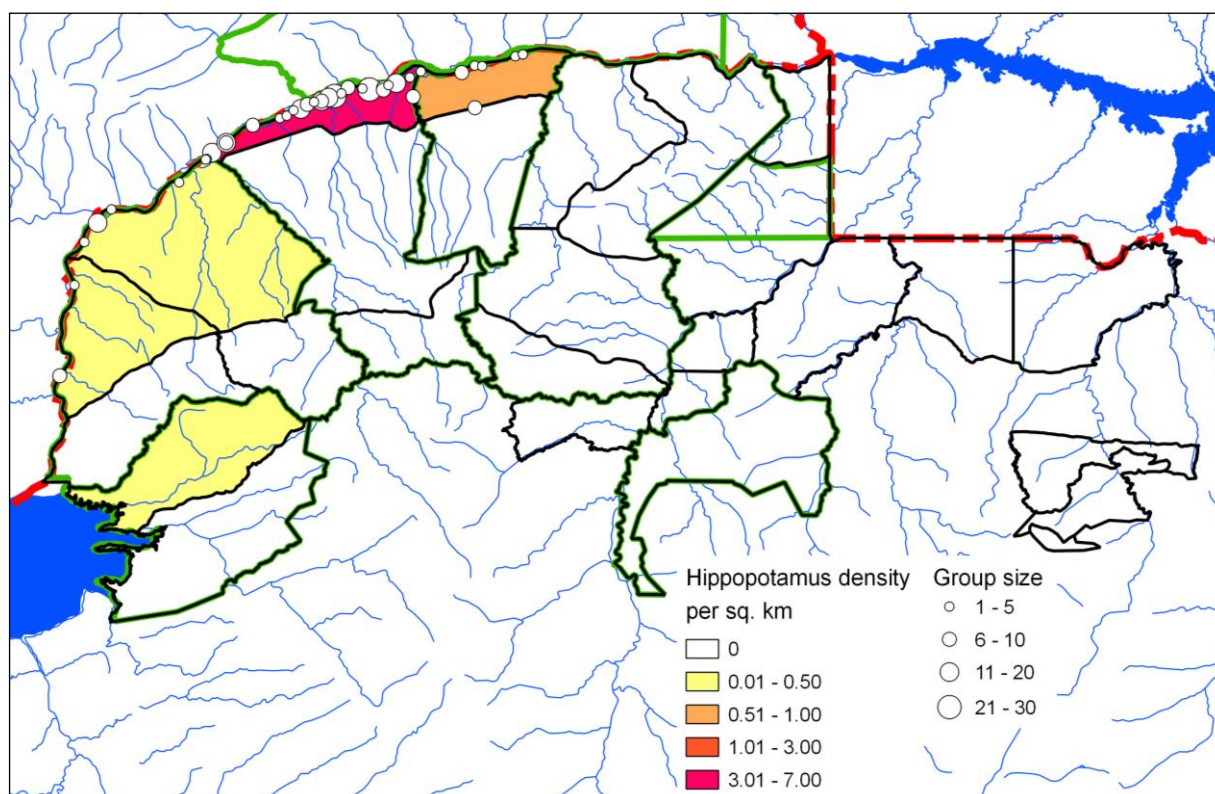


Map 18. Distribution of eland in the Zambezi Valley during 2014

Table 20. Population estimates and statistics for Hippopotamus in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	2122	234	215908	44.7	1174	3070	6.65
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	2122	234	215908	44.7	1174	3070	0.98
Hurungwe SA							
Rifa	114	8	7712	164.1	8	301	0.19
Hurungwe	284	31	27723	118.6	31	621	0.24
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	398	39	35435	94.9	39	776	0.13
Sapi SA							
Sapi North	288	31	19274	99.7	31	575	0.91
Sapi South	0	0	0	0.0	0	0	0
Subtotals	288	31	19274	99.7	31	575	0.26
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Charara SA							
North Charara	113	21	12811	236.5	21	381	0.15
South Charara	0	0	0	0.0	0	0	0
Subtotals	113	21	12811	236.5	21	381	0.07
Doma SA							
Doma	0	0	0	0.0	0	0	0

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	2921	325	283427	36.6	1853	3990	0.17



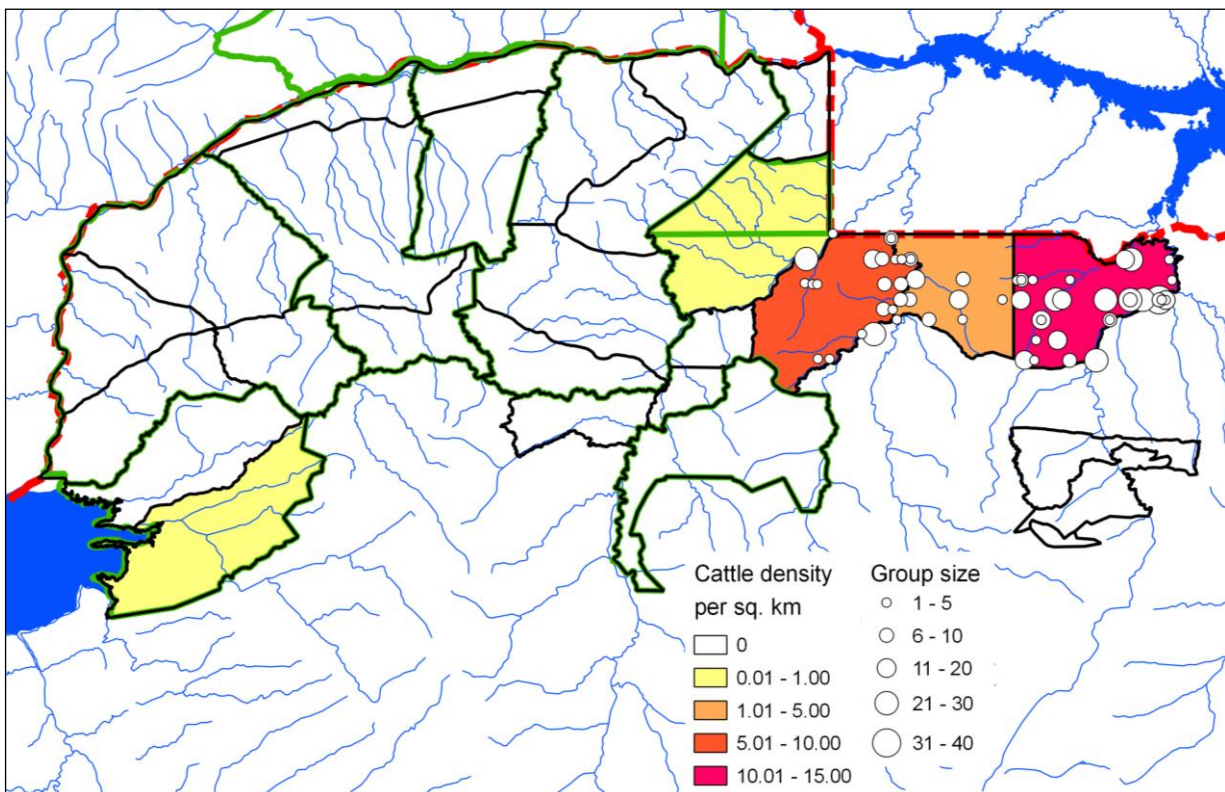
Map 19. Distribution of hippopotamus in the Zambezi Valley during 2014

Table 21. Population estimates and statistics for Cattle in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	0	0	0	0.0	0	0	0
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	0	0	0	0.0	0	0	0
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	84	16	7068	236.5	16	283	0.09
Subtotals	84	16	7068	236.5	16	283	0.05
Doma SA							
Doma	0	0	0	0.0	0	0	0

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Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	58	3	3494	222.1	3	187	0.06
Chapoto	0	0	0	0.0	0	0	0
Chisunga	4009	124	1779533	81.4	744	7273	5.28
Kadze West	2557	97	322745	57.1	1097	4018	4.32
Kadze East	11188	405	25210062	109.8	405	23474	14.36
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	17812	629	27315833	69.4	5454	30171	4.74
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	17896	645	27322902	69.1	5536	30257	1.05

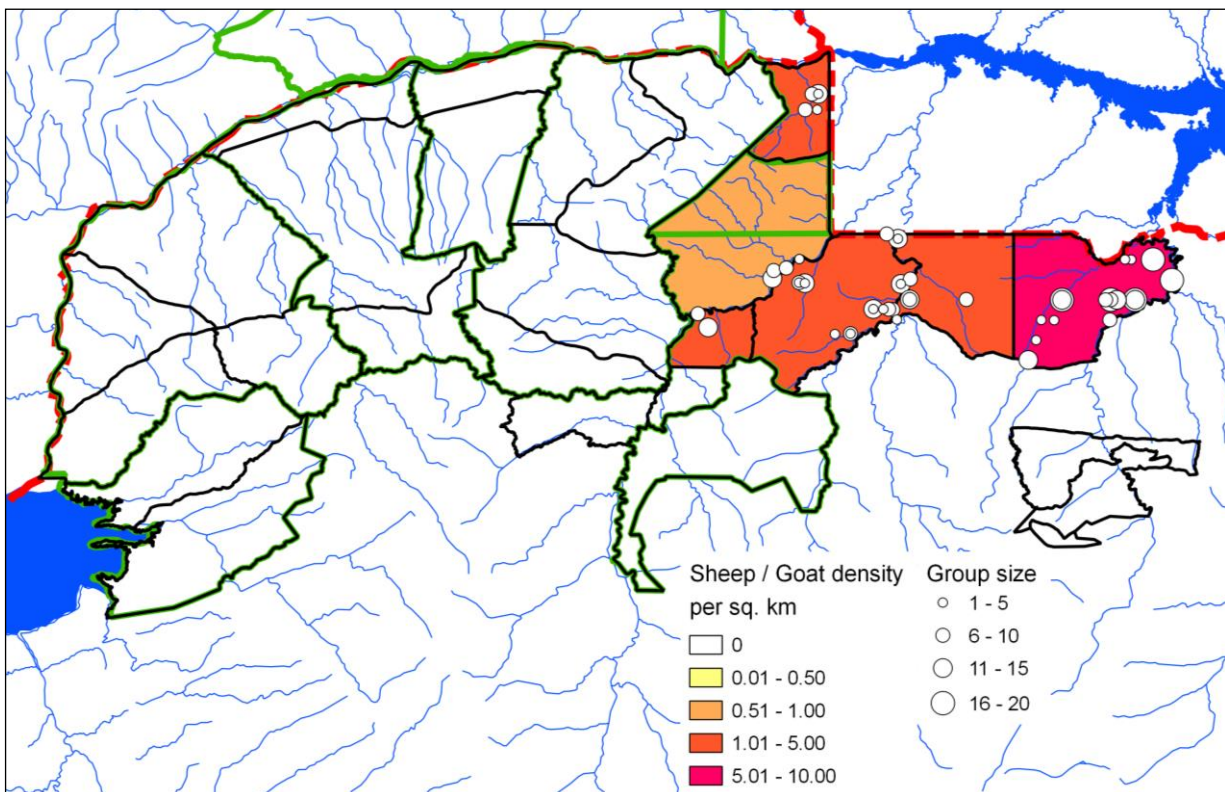


Map 20. Distribution of cattle in the Zambezi Valley during 2014

Table 22. Population estimates and statistics for Sheep and Goats in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	0	0	0	0.0	0	0	0
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	0	0	0	0.0	0	0	0
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Doma SA							
Doma	0	0	0	0.0	0	0	0

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Communal Lands							
Guruve District							
Dande	561	29	153807	152.5	29	1415	0.57
Chapoto	787	34	244345	153.7	34	1997	2.79
Chisunga	3750	116	1051582	66.9	1241	6259	4.94
Kadze West	1476	56	585533	133.3	56	3444	2.49
Kadze East	6409	232	12590773	135.5	232	15092	8.23
Kanyurira	332	20	49872	186.7	20	952	1.60
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	13315	487	14675911	66.3	4481	22149	3.54
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	13315	487	14675911	66.3	4481	22149	0.78



Map 21. Distribution of sheep and goats in the Zambezi Valley during 2014

Table 23. Population estimates and statistics for Donkeys in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	0	0	0	0.0	0	0	0
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	0	0	0	0.0	0	0	0
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Doma SA							
Doma	0	0	0	0.0	0	0	0

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Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Other Districts							
MWA high density	9	3	74	277.6	3	33	0.03
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	9	3	74	277.6	3	33	0.01
Totals	9	3	74	277.6	3	33	0.001

Table 24. Population estimates and statistics for Ground Hornbill in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	27	3	675	194.9	3	80	0.09
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	27	3	675	194.8	3	80	0.01
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	0	0	0	0.0	0	0	0
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Sapi SA							
Sapi North	0	0	0	0.0	0	0	0
Sapi South	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	9	2	79	210.1	2	28	0.01
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	9	2	79	210.1	2	28	0.003
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Doma SA							
Doma	0	0	0	0.0	0	0	0

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Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	36	5	755	154.1	5	92	0.002

Table 25. Population estimates and statistics for large Crocodiles in the Zambezi Valley

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Parks & Wild Life Estate							
Mana Pools NP							
Mana I	399	44	22438	76.6	93	705	1.25
Mana II	0	0	0	0.0	0	0	0
Mana Escarpment	0	0	0	0.0	0	0	0
Subtotals	399	44	22438	76.6	93	705	0.18
Hurungwe SA							
Rifa	0	0	0	0.0	0	0	0
Hurungwe	9	1	75	191.0	1	27	0.008
Hurungwe I	0	0	0	0.0	0	0	0
Hurungwe II Marongora	0	0	0	0.0	0	0	0
Subtotals	9	1	75	191.0	1	27	0.003
Sapi SA							
Sapi North	121	13	1279	61.3	47	195	0.38
Sapi South	0	0	0	0.0	0	0	0
Subtotals	121	13	1279	61.3	47	195	0.11
Chewore SA							
Chewore I	0	0	0	0.0	0	0	0
Chewore II Hills	0	0	0	0.0	0	0	0
Chewore III	0	0	0	0.0	0	0	0
Chewore IV Escarpment	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Charara SA							
North Charara	0	0	0	0.0	0	0	0
South Charara	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Doma SA							
Doma	0	0	0	0.0	0	0	0

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Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km²)
Communal Lands							
Guruve District							
Dande	0	0	0	0.0	0	0	0
Chapoto	0	0	0	0.0	0	0	0
Chisunga	0	0	0	0.0	0	0	0
Kadze West	0	0	0	0.0	0	0	0
Kadze East	0	0	0	0.0	0	0	0
Kanyurira	0	0	0	0.0	0	0	0
Kanyurira Highlands	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Other Districts							
MWA high density	0	0	0	0.0	0	0	0
MWA low density	0	0	0	0.0	0	0	0
Mukwiche	0	0	0	0.0	0	0	0
Subtotals	0	0	0	0.0	0	0	0.00
Totals	529	58	23792	59.3	216	842	0.030

Appendix 1. Calibration of strip width

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

- Strip width (in meters) for one observer = 10 x (1 + 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 Mana Pools on 20 August (runs 1-25) and 25 August (runs 26-31).

Run no.	Left observer: Douglas Kuramba			Right observer: Greg Nyaguse			Combined strip width (m) at flying height	Flying height agl (ft)	Strip width (m) when flying at 300 ft		
	Outer marker	Inner marker	Strip width (m)	Outer marker	Inner marker	Strip width (m)			Combined	Left	Right
1	28	11	180	24	7	180	360	294	367	184	184
2	31	13	190	24	8	170	360	285	379	200	179
3	28	12	170	22	6	170	340	304	336	168	168
4	25	11	150	27	11	170	320	279	344	161	183
5	30	15	160	23	7	170	330	301	329	159	169
6	30	11	200	18	7	120	320	250	384	240	144
7	28	14	150	17	2	160	310	286	325	157	168
8	23	9	150	18	6	130	280	248	339	181	157
9	28	13	160	20	4	170	330	264	375	182	193
10	28	11	180	18	7	120	300	240	375	225	150
11	32	16	170	20	5	160	330	341	290	150	141
12	34	15	200	26	11	160	360	344	314	174	140
13	32	17	160	22	5	180	340	338	302	142	160
14	34	18	170	22	8	150	320	310	310	165	145
15	34	17	180	25	7	190	370	350	317	154	163
16	32	17	160	25	11	150	310	320	291	150	141
17	29	14	160	17	4	140	300	319	282	150	132
18	32	17	160	21	6	160	320	313	307	153	153
19	30	14	170	25	14		-	361	-	141	-
20	31	15	170	27	6	220	390	355	330	144	186
21	30	13	180	20	8	130	310	305	305	177	128
22	30	16	150	20	5	160	310	308	302	146	156
23	23	9	150	20	8	130	280	253	332	178	154
24	32	17	160	14	3	120	280	282	298	170	128
25	24	11	140	18	7	120	260	249	313	169	145
26	34	18	170	17	1	170	340	281	363	181	181
27	28	11	180	25	8	180	360	307	352	176	176
28	21	8	140	22	7	160	300	253	356	166	190
29	29	11	190	22	5	180	370	258	430	221	209
30	33	18	160	29	10	200	360	344	314	140	174
31	34	17	180	26	7	200	380	358	318	151	168
Mean strip width (in meters) when flying at 300 feet agl =									170	162	
Standard error of mean strip width as a percentage of the mean									2.6	2.3	

Appendix 2. Flight summary for Zambezi Valley survey

Date	Time take off	Time land	Flight time (hours)	Duty
26-Jun-14	12:19	13:50	1.52	Supercub positioning, Harare to Makuti
27-Jun-14	7:11	10:32	3.35	Stratum South Charara
28-Jun-14	6:54	10:05	3.18	Stratum North Charara
29-Jun-14	6:52	9:53	3.02	Stratum Hurungwe I
30-Jun-14	6:51	9:38	2.78	Stratum Hurungwe II Marongora blocks 23, 10, 17, 30, 38, 40, 14, 12
01-Jul-14	7:27	10:20	2.88	Strata Mana Escarpment & Hurungwe II Marongora block 27
03-Jul-14	7:32	10:46	3.23	Stratum Chewore Escarpment
04-Jul-14	9:22	12:27	3.08	Stratum Mukwiche
04-Jul-14	13:11	14:12	1.02	Positioning, Makuti to Pedza
05-Jul-14	7:58	10:37	2.65	Stratum Chewore Hills blocks 94, 92, 84, 73, 66, 52
06-Jul-14	7:33	10:05	2.53	Stratum Chewore Hills blocks 23, 34, 28, 11, 12, 35
06-Jul-14	14:46	16:33	1.78	Stratum Chewore Hills blocks 76, 74, 95,
07-Jul-14	7:42	10:23	2.68	Stratum Chewore Hills blocks 53, 50 & Stratum Kanyurira Highlands
09-Jul-14	6:53	10:01	3.13	Stratum Doma blocks 26, 37, 47, 49, 70, 71, 67, 64
09-Jul-14	14:40	16:39	1.98	Stratum Doma blocks 59, 81, 94, 38
10-Jul-14	7:05	10:16	3.18	Stratum Mavuradonha blocks 1, 10, 40, 27, 26, 30
11-Jul-14	7:10	9:22	2.20	Stratum Mavuradonha blocks 37, 44, 45
11-Jul-14	15:04	16:05	1.02	Supercub positioning, Pedza to Kariba
18-Aug-14			1.40	Cessna 206 positioning, Harare to Mana West
19-Aug-14	8:09	8:55	0.77	Calibration, Mana Pools
20-Aug-14	7:57	8:51	0.90	Calibration, Mana Pools
20-Aug-14	9:35	10:25	0.83	Calibration, land Mana Pools
20-Aug-14	10:48	11:00	0.20	Return Mana West
20-Aug-14	15:06	16:25	1.32	Calibration, training
21-Aug-14	7:50	10:57	3.12	Stratum Rifa; Stratum Hurungwe transects 1-6
21-Aug-14	14:53	16:35	1.70	Stratum Hurungwe transects 7-16
22-Aug-14	7:50	10:38	2.80	Stratum Hurungwe transects 17-26
22-Aug-14	15:05	17:02	1.95	Stratum Hurungwe transects 27-39
23-Aug-14	7:31	10:55	3.40	Stratum Mana 2, transects 1-12
23-Aug-14	15:22	17:00	1.63	Stratum Mana 2, transects 13-23 odd numbers only
25-Aug-14	8:20	11:13	2.88	Stratum Mana 1
25-Aug-14	14:47	16:53	2.10	Stratum Sapi North, transects 1-17
26-Aug-14			0.50	Positioning, Mana West to Chenje
27-Aug-14	8:17	8:22	0.08	Aircraft check

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date	Time take off	Time land	Flight time (hours)	Duty
27-Aug-14	8:29	11:30	3.02	Strata Sapi N, transects 18-24; Sapi South, transects 1-17 odd numbers
27-Aug-14	11:55	12:10	0.25	Refuel Pedza, transfer to Chenje
27-Aug-14	15:25	17:20	1.92	Stratum Chisunga
28-Aug-14	7:18	10:33	3.25	Stratum Chewore 1, odd numbered transects; Sapi South, transects 19, 21
28-Aug-14	11:07	11:21	0.23	Refuel Pedza, transfer to Chenje
28-Aug-14	15:00	16:44	1.73	Stratum Kadze West
29-Aug-14	7:15	10:10	2.92	Stratum Chewore 3, odd numbered transects
29-Aug-14	10:45	11:01	0.27	Refuel Pedza, transfer to Chenje
29-Aug-14	14:46	17:05	2.32	Stratum Kadze East
30-Aug-14	7:16	9:08	1.87	Stratum Dande, transects 25-9 odd numbers
30-Aug-14	9:37	10:57	1.33	Stratum Dande, transects 7-1 odd numbers
30-Aug-14	15:06	16:10	1.07	Stratum Chapoto
30-Aug-14	16:37	16:52	0.25	Refuel Pedza, transfer to Chenje
31-Aug-14	7:17	9:31	2.23	Stratum Kanyurira; stratum Mana 2, transects 25,24,22,20
31-Aug-14	10:12	11:06	0.90	Cessna 206 positioning, Chenje to Harare
Total			94.35	

Appendix 3. Transect start and end points, and lengths

Degrees and decimal minutes; datum WGS84

Rifa

Number of transects : 16
Transect Bearing : 90.00 Degrees
Transect Spacing : 2.30 km

Transect # : 1
Start Lat : S 16 : 3.292 Start Lon : E 28 : 54.479
Finish Lat : S 16 : 3.292 Finish Lon : E 28 : 50.935
Length : 6.31 km

Transect # : 2
Start Lat : S 16 : 4.534 Start Lon : E 28 : 51.456
Finish Lat : S 16 : 4.534 Finish Lon : E 28 : 57.980
Length : 11.61 km

Transect # : 3
Start Lat : S 16 : 5.776 Start Lon : E 28 : 59.553
Finish Lat : S 16 : 5.776 Finish Lon : E 28 : 51.949
Length : 13.54 km

Transect # : 4
Start Lat : S 16 : 7.018 Start Lon : E 28 : 51.836
Finish Lat : S 16 : 7.018 Finish Lon : E 29 : 1.166
Length : 16.61 km

Transect # : 5
Start Lat : S 16 : 8.260 Start Lon : E 29 : 2.909
Finish Lat : S 16 : 8.260 Finish Lon : E 28 : 51.475
Length : 20.35 km

Transect # : 6
Start Lat : S 16 : 9.502 Start Lon : E 28 : 50.507
Finish Lat : S 16 : 9.502 Finish Lon : E 29 : 7.349
Length : 29.98 km

Transect # : 7
Start Lat : S 16 : 10.744 Start Lon : E 29 : 8.812
Finish Lat : S 16 : 10.744 Finish Lon : E 28 : 50.292
Length : 32.97 km

Transect # : 8
Start Lat : S 16 : 11.986 Start Lon : E 28 : 50.376
Finish Lat : S 16 : 11.986 Finish Lon : E 29 : 8.126
Length : 31.60 km

Transect # : 9
Start Lat : S 16 : 13.228 Start Lon : E 29 : 3.700
Finish Lat : S 16 : 13.228 Finish Lon : E 28 : 50.247
Length : 23.95 km

Transect # : 10
Start Lat : S 16 : 14.470 Start Lon : E 28 : 51.435
Finish Lat : S 16 : 14.470 Finish Lon : E 29 : 2.302
Length : 19.34 km

Transect # : 11
Start Lat : S 16 : 15.712 Start Lon : E 29 : 0.440
Finish Lat : S 16 : 15.712 Finish Lon : E 28 : 51.019
Length : 16.77 km

Transect # : 12
Start Lat : S 16 : 16.954 Start Lon : E 28 : 50.106
Finish Lat : S 16 : 16.954 Finish Lon : E 28 : 58.039
Length : 14.12 km

Transect # : 13
Start Lat : S 16 : 18.196 Start Lon : E 28 : 56.724
Finish Lat : S 16 : 18.196 Finish Lon : E 28 : 49.522
Length : 12.82 km

Transect # : 14
Start Lat : S 16 : 19.438 Start Lon : E 28 : 49.815
Finish Lat : S 16 : 19.438 Finish Lon : E 28 : 55.516
Length : 10.15 km

Transect # : 15
Start Lat : S 16 : 20.680 Start Lon : E 28 : 53.312
Finish Lat : S 16 : 20.680 Finish Lon : E 28 : 50.523
Length : 4.97 km

Transect # : 16
Start Lat : S 16 : 21.922 Start Lon : E 28 : 50.914
Finish Lat : S 16 : 21.922 Finish Lon : E 28 : 51.731
Length : 1.46 km

Hurungwe

Number of transects : 39
Transect Bearing : 0.00 Degrees
Transect Spacing : 1.50 km

Transect # : 1
Start Lat : S 16 : 2.064 Start Lon : E 28 : 51.437
Finish Lat : S 16 : 2.478 Finish Lon : E 28 : 51.437
Length : 0.77 km

Transect # : 2
Start Lat : S 16 : 2.572 Start Lon : E 28 : 52.278
Finish Lat : S 16 : 1.584 Finish Lon : E 28 : 52.278
Length : 1.83 km

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Transect # : 3
Start Lat : S 15 : 59.555 Start Lon : E 28 : 53.120
Finish Lat : S 16 : 2.278 Finish Lon : E 28 : 53.120
Length : 5.04 km

Transect # : 4
Start Lat : S 16 : 2.725 Start Lon : E 28 : 53.961
Finish Lat : S 15 : 58.360 Finish Lon : E 28 : 53.961
Length : 8.08 km

Transect # : 5
Start Lat : S 15 : 57.633 Start Lon : E 28 : 54.803
Finish Lat : S 16 : 3.532 Finish Lon : E 28 : 54.803
Length : 10.92 km

Transect # : 6
Start Lat : S 16 : 4.029 Start Lon : E 28 : 55.644
Finish Lat : S 15 : 56.570 Finish Lon : E 28 : 55.644
Length : 13.81 km

Transect # : 7
Start Lat : S 15 : 56.430 Start Lon : E 28 : 56.485
Finish Lat : S 16 : 4.073 Finish Lon : E 28 : 56.485
Length : 14.15 km

Transect # : 8
Start Lat : S 16 : 4.180 Start Lon : E 28 : 57.327
Finish Lat : S 15 : 56.510 Finish Lon : E 28 : 57.327
Length : 14.20 km

Transect # : 9
Start Lat : S 15 : 56.597 Start Lon : E 28 : 58.168
Finish Lat : S 16 : 4.691 Finish Lon : E 28 : 58.168
Length : 14.99 km

Transect # : 10
Start Lat : S 16 : 5.389 Start Lon : E 28 : 59.010
Finish Lat : S 15 : 56.470 Finish Lon : E 28 : 59.010
Length : 16.52 km

Transect # : 11
Start Lat : S 15 : 56.500 Start Lon : E 28 : 59.851
Finish Lat : S 16 : 6.043 Finish Lon : E 28 : 59.851
Length : 17.67 km

Transect # : 12
Start Lat : S 16 : 6.690 Start Lon : E 29 : 0.692
Finish Lat : S 15 : 56.784 Finish Lon : E 29 : 0.692
Length : 18.34 km

Transect # : 13
Start Lat : S 15 : 56.271 Start Lon : E 29 : 1.534
Finish Lat : S 16 : 7.458 Finish Lon : E 29 : 1.534
Length : 20.72 km

Transect # : 14
Start Lat : S 16 : 8.068 Start Lon : E 29 : 2.375
Finish Lat : S 15 : 54.605 Finish Lon : E 29 : 2.375
Length : 24.93 km

Transect # : 15
Start Lat : S 15 : 53.650 Start Lon : E 29 : 3.216
Finish Lat : S 16 : 8.331 Finish Lon : E 29 : 3.216
Length : 27.19 km

Transect # : 16
Start Lat : S 16 : 8.526 Start Lon : E 29 : 4.058
Finish Lat : S 15 : 52.998 Finish Lon : E 29 : 4.058
Length : 28.76 km

Transect # : 17
Start Lat : S 15 : 52.682 Start Lon : E 29 : 4.899
Finish Lat : S 16 : 8.713 Finish Lon : E 29 : 4.899
Length : 29.69 km

Transect # : 18
Start Lat : S 16 : 8.857 Start Lon : E 29 : 5.741
Finish Lat : S 15 : 51.959 Finish Lon : E 29 : 5.741
Length : 31.29 km

Transect # : 19
Start Lat : S 15 : 51.101 Start Lon : E 29 : 6.582
Finish Lat : S 16 : 8.961 Finish Lon : E 29 : 6.582
Length : 33.07 km

Transect # : 20
Start Lat : S 16 : 9.560 Start Lon : E 29 : 7.423
Finish Lat : S 15 : 50.457 Finish Lon : E 29 : 7.423
Length : 35.38 km

Transect # : 21
Start Lat : S 15 : 50.079 Start Lon : E 29 : 8.265
Finish Lat : S 16 : 10.230 Finish Lon : E 29 : 8.265
Length : 37.32 km

Transect # : 22
Start Lat : S 16 : 10.810 Start Lon : E 29 : 9.106
Finish Lat : S 15 : 50.351 Finish Lon : E 29 : 9.106
Length : 37.89 km

Transect # : 23
Start Lat : S 15 : 50.684 Start Lon : E 29 : 9.948
Finish Lat : S 16 : 11.619 Finish Lon : E 29 : 9.948
Length : 38.77 km

Transect # : 24
Start Lat : S 16 : 11.464 Start Lon : E 29 : 10.789
Finish Lat : S 15 : 51.199 Finish Lon : E 29 : 10.789
Length : 37.53 km

Transect # : 25
Start Lat : S 15 : 51.638 Start Lon : E 29 : 11.630
Finish Lat : S 16 : 11.098 Finish Lon : E 29 : 11.630
Length : 36.04 km

Transect # : 26
Start Lat : S 16 : 10.757 Start Lon : E 29 : 12.472
Finish Lat : S 15 : 52.879 Finish Lon : E 29 : 12.472
Length : 33.11 km

Transect # : 27A
Start Lat : S 15 : 53.784 Start Lon : E 29 : 13.313
Finish Lat : S 15 : 54.017 Finish Lon : E 29 : 13.313
Length : 0.43 km

Transect # : 27B
Start Lat : S 15 : 54.050 Start Lon : E 29 : 13.313
Finish Lat : S 16 : 10.465 Finish Lon : E 29 : 13.313
Length : 30.40 km

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Transect # : 28
Start Lat : S 16 : 10.383 Start Lon : E 29 : 14.155
Finish Lat : S 15 : 54.774 Finish Lon : E 29 : 14.155
Length : 28.91 km

Transect # : 29
Start Lat : S 15 : 55.634 Start Lon : E 29 : 14.996
Finish Lat : S 16 : 10.221 Finish Lon : E 29 : 14.996
Length : 27.01 km

Transect # : 30
Start Lat : S 16 : 10.182 Start Lon : E 29 : 15.837
Finish Lat : S 15 : 56.393 Finish Lon : E 29 : 15.837
Length : 25.54 km

Transect # : 31
Start Lat : S 15 : 56.851 Start Lon : E 29 : 16.679
Finish Lat : S 16 : 10.062 Finish Lon : E 29 : 16.679
Length : 24.46 km

Transect # : 32
Start Lat : S 16 : 10.196 Start Lon : E 29 : 17.520
Finish Lat : S 15 : 57.972 Finish Lon : E 29 : 17.520
Length : 22.64 km

Transect # : 33
Start Lat : S 15 : 58.912 Start Lon : E 29 : 18.361
Finish Lat : S 16 : 9.580 Finish Lon : E 29 : 18.361
Length : 19.75 km

Transect # : 34
Start Lat : S 16 : 8.142 Start Lon : E 29 : 19.203
Finish Lat : S 15 : 59.690 Finish Lon : E 29 : 19.203
Length : 15.65 km

Transect # : 35
Start Lat : S 16 : 0.103 Start Lon : E 29 : 20.044
Finish Lat : S 16 : 5.773 Finish Lon : E 29 : 20.044
Length : 10.50 km

Transect # : 36
Start Lat : S 16 : 4.746 Start Lon : E 29 : 20.886
Finish Lat : S 16 : 0.582 Finish Lon : E 29 : 20.886
Length : 7.71 km

Transect # : 37
Start Lat : S 16 : 1.521 Start Lon : E 29 : 21.727
Finish Lat : S 16 : 3.935 Finish Lon : E 29 : 21.727
Length : 4.47 km

Transect # : 38
Start Lat : S 16 : 3.402 Start Lon : E 29 : 22.568
Finish Lat : S 16 : 2.259 Finish Lon : E 29 : 22.568
Length : 2.12 km

Transect # : 39
Start Lat : S 16 : 2.751 Start Lon : E 29 : 23.410
Finish Lat : S 16 : 2.810 Finish Lon : E 29 : 23.410
Length : 0.11 km

Mana I

Number of transects : 32
Transect Bearing : 0.00 Degrees
Transect Spacing : 1.50 km

Transect # : 1
Start Lat : S 15 : 49.905 Start Lon : E 29 : 8.161
Finish Lat : S 15 : 49.981 Finish Lon : E 29 : 8.161
Length : 0.14 km

Transect # : 2
Start Lat : S 15 : 50.338 Start Lon : E 29 : 9.002
Finish Lat : S 15 : 49.163 Finish Lon : E 29 : 9.002
Length : 2.18 km

Transect # : 3
Start Lat : S 15 : 48.558 Start Lon : E 29 : 9.842
Finish Lat : S 15 : 50.618 Finish Lon : E 29 : 9.842
Length : 3.82 km

Transect # : 4
Start Lat : S 15 : 49.759 Start Lon : E 29 : 10.683
Finish Lat : S 15 : 48.021 Finish Lon : E 29 : 10.683
Length : 3.22 km

Transect # : 5
Start Lat : S 15 : 47.483 Start Lon : E 29 : 11.524
Finish Lat : S 15 : 49.488 Finish Lon : E 29 : 11.524
Length : 3.71 km

Transect # : 6
Start Lat : S 15 : 49.216 Start Lon : E 29 : 12.364
Finish Lat : S 15 : 46.720 Finish Lon : E 29 : 12.364
Length : 4.62 km

Transect # : 7
Start Lat : S 15 : 46.157 Start Lon : E 29 : 13.205
Finish Lat : S 15 : 48.944 Finish Lon : E 29 : 13.205
Length : 5.16 km

Transect # : 8
Start Lat : S 15 : 48.672 Start Lon : E 29 : 14.045
Finish Lat : S 15 : 46.009 Finish Lon : E 29 : 14.045
Length : 4.93 km

Transect # : 9
Start Lat : S 15 : 45.944 Start Lon : E 29 : 14.886
Finish Lat : S 15 : 48.401 Finish Lon : E 29 : 14.886
Length : 4.55 km

Transect # : 10
Start Lat : S 15 : 48.129 Start Lon : E 29 : 15.726
Finish Lat : S 15 : 45.707 Finish Lon : E 29 : 15.726
Length : 4.49 km

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Transect # : 11
Start Lat : S 15 : 45.371 Start Lon : E 29 : 16.567
Finish Lat : S 15 : 47.857 Finish Lon : E 29 : 16.567
Length : 4.60 km

Transect # : 12
Start Lat : S 15 : 47.585 Start Lon : E 29 : 17.407
Finish Lat : S 15 : 45.010 Finish Lon : E 29 : 17.407
Length : 4.77 km

Transect # : 13
Start Lat : S 15 : 44.512 Start Lon : E 29 : 18.248
Finish Lat : S 15 : 47.313 Finish Lon : E 29 : 18.248
Length : 5.19 km

Transect # : 14
Start Lat : S 15 : 47.042 Start Lon : E 29 : 19.088
Finish Lat : S 15 : 44.031 Finish Lon : E 29 : 19.088
Length : 5.57 km

Transect # : 15
Start Lat : S 15 : 43.754 Start Lon : E 29 : 19.929
Finish Lat : S 15 : 46.770 Finish Lon : E 29 : 19.929
Length : 5.59 km

Transect # : 16
Start Lat : S 15 : 46.498 Start Lon : E 29 : 20.769
Finish Lat : S 15 : 43.424 Finish Lon : E 29 : 20.769
Length : 5.69 km

Transect # : 17
Start Lat : S 15 : 43.059 Start Lon : E 29 : 21.610
Finish Lat : S 15 : 46.226 Finish Lon : E 29 : 21.610
Length : 5.86 km

Transect # : 18
Start Lat : S 15 : 46.168 Start Lon : E 29 : 22.450
Finish Lat : S 15 : 42.765 Finish Lon : E 29 : 22.450
Length : 6.30 km

Transect # : 19
Start Lat : S 15 : 42.505 Start Lon : E 29 : 23.291
Finish Lat : S 15 : 46.771 Finish Lon : E 29 : 23.291
Length : 7.90 km

Transect # : 20
Start Lat : S 15 : 47.168 Start Lon : E 29 : 24.131
Finish Lat : S 15 : 42.125 Finish Lon : E 29 : 24.131
Length : 9.34 km

Transect # : 21
Start Lat : S 15 : 41.575 Start Lon : E 29 : 24.972
Finish Lat : S 15 : 46.911 Finish Lon : E 29 : 24.972
Length : 9.88 km

Transect # : 22
Start Lat : S 15 : 46.438 Start Lon : E 29 : 25.812
Finish Lat : S 15 : 41.373 Finish Lon : E 29 : 25.812
Length : 9.38 km

Transect # : 23
Start Lat : S 15 : 41.273 Start Lon : E 29 : 26.653
Finish Lat : S 15 : 46.154 Finish Lon : E 29 : 26.653
Length : 9.04 km

Transect # : 24
Start Lat : S 15 : 45.935 Start Lon : E 29 : 27.493
Finish Lat : S 15 : 41.310 Finish Lon : E 29 : 27.493
Length : 8.56 km

Transect # : 25
Start Lat : S 15 : 41.450 Start Lon : E 29 : 28.334
Finish Lat : S 15 : 45.787 Finish Lon : E 29 : 28.334
Length : 8.03 km

Transect # : 26
Start Lat : S 15 : 45.826 Start Lon : E 29 : 29.174
Finish Lat : S 15 : 41.484 Finish Lon : E 29 : 29.174
Length : 8.04 km

Transect # : 27
Start Lat : S 15 : 41.263 Start Lon : E 29 : 30.015
Finish Lat : S 15 : 45.772 Finish Lon : E 29 : 30.015
Length : 8.35 km

Transect # : 28
Start Lat : S 15 : 45.695 Start Lon : E 29 : 30.855
Finish Lat : S 15 : 40.934 Finish Lon : E 29 : 30.855
Length : 8.82 km

Transect # : 29
Start Lat : S 15 : 40.335 Start Lon : E 29 : 31.696
Finish Lat : S 15 : 46.304 Finish Lon : E 29 : 31.696
Length : 11.06 km

Transect # : 30
Start Lat : S 15 : 46.680 Start Lon : E 29 : 32.536
Finish Lat : S 15 : 39.633 Finish Lon : E 29 : 32.536
Length : 13.05 km

Transect # : 31
Start Lat : S 15 : 39.012 Start Lon : E 29 : 33.377
Finish Lat : S 15 : 46.496 Finish Lon : E 29 : 33.377
Length : 13.86 km

Transect # : 32A
Start Lat : S 15 : 45.790 Start Lon : E 29 : 34.217
Finish Lat : S 15 : 44.494 Finish Lon : E 29 : 34.217
Length : 2.40 km

Transect # : 32B
Start Lat : S 15 : 44.484 Start Lon : E 29 : 34.217
Finish Lat : S 15 : 43.730 Finish Lon : E 29 : 34.217
Length : 1.40 km

Transect # : 32C
Start Lat : S 15 : 43.258 Start Lon : E 29 : 34.217
Finish Lat : S 15 : 43.082 Finish Lon : E 29 : 34.217
Length : 0.33 km

Transect # : 32D
Start Lat : S 15 : 40.343 Start Lon : E 29 : 34.217
Finish Lat : S 15 : 38.739 Finish Lon : E 29 : 34.217
Length : 2.97 km

Mana II

Number of transects : 22

Transect Bearing : 90.00 Degrees

Transect Spacing : 1.80 km

Transect # : 1A

Start Lat : S 15 : 45.733 Start Lon : E 29 : 30.326
Finish Lat : S 15 : 45.733 Finish Lon : E 29 : 30.909
Length : 1.04 km

Transect # : 1B

Start Lat : S 15 : 45.733 Start Lon : E 29 : 34.289
Finish Lat : S 15 : 45.733 Finish Lon : E 29 : 34.815
Length : 0.94 km

Transect # : 2A

Start Lat : S 15 : 46.705 Start Lon : E 29 : 34.927
Finish Lat : S 15 : 46.705 Finish Lon : E 29 : 32.976
Length : 3.48 km

Transect # : 2B

Start Lat : S 15 : 46.705 Start Lon : E 29 : 32.757
Finish Lat : S 15 : 46.705 Finish Lon : E 29 : 25.337
Length : 13.23 km

Transect # : 2C

Start Lat : S 15 : 46.705 Start Lon : E 29 : 23.201
Finish Lat : S 15 : 46.705 Finish Lon : E 29 : 20.128
Length : 5.48 km

Transect # : 3

Start Lat : S 15 : 47.677 Start Lon : E 29 : 17.122
Finish Lat : S 15 : 47.677 Finish Lon : E 29 : 36.317
Length : 34.23 km

Transect # : 4

Start Lat : S 15 : 48.649 Start Lon : E 29 : 35.985
Finish Lat : S 15 : 48.649 Finish Lon : E 29 : 14.116
Length : 38.99 km

Transect # : 5

Start Lat : S 15 : 49.621 Start Lon : E 29 : 11.110
Finish Lat : S 15 : 49.621 Finish Lon : E 29 : 35.431
Length : 43.37 km

Transect # : 6

Start Lat : S 15 : 50.593 Start Lon : E 29 : 35.220
Finish Lat : S 15 : 50.593 Finish Lon : E 29 : 10.015
Length : 44.94 km

Transect # : 7

Start Lat : S 15 : 51.565 Start Lon : E 29 : 11.304
Finish Lat : S 15 : 51.565 Finish Lon : E 29 : 35.013
Length : 42.28 km

Transect # : 8

Start Lat : S 15 : 52.537 Start Lon : E 29 : 34.699
Finish Lat : S 15 : 52.537 Finish Lon : E 29 : 12.331
Length : 39.88 km

Transect # : 9

Start Lat : S 15 : 53.509 Start Lon : E 29 : 12.767
Finish Lat : S 15 : 53.509 Finish Lon : E 29 : 34.750
Length : 39.20 km

Transect # : 10

Start Lat : S 15 : 54.481 Start Lon : E 29 : 34.920
Finish Lat : S 15 : 54.481 Finish Lon : E 29 : 13.658
Length : 37.91 km

Transect # : 11

Start Lat : S 15 : 55.453 Start Lon : E 29 : 14.873
Finish Lat : S 15 : 55.453 Finish Lon : E 29 : 35.119
Length : 36.10 km

Transect # : 12

Start Lat : S 15 : 56.425 Start Lon : E 29 : 34.861
Finish Lat : S 15 : 56.425 Finish Lon : E 29 : 15.860
Length : 33.88 km

Transect # : 13

Start Lat : S 15 : 57.397 Start Lon : E 29 : 17.099
Finish Lat : S 15 : 57.397 Finish Lon : E 29 : 34.835
Length : 31.63 km

Transect # : 15

Start Lat : S 15 : 59.341 Start Lon : E 29 : 34.446
Finish Lat : S 15 : 59.341 Finish Lon : E 29 : 19.046
Length : 27.46 km

Transect # : 17

Start Lat : S 16 : 1.285 Start Lon : E 29 : 21.522
Finish Lat : S 16 : 1.285 Finish Lon : E 29 : 33.984
Length : 22.22 km

Transect # : 19

Start Lat : S 16 : 3.229 Start Lon : E 29 : 40.209
Finish Lat : S 16 : 3.229 Finish Lon : E 29 : 22.838
Length : 30.97 km

Transect # : 20

Start Lat : S 16 : 4.201 Start Lon : E 29 : 21.403
Finish Lat : S 16 : 4.201 Finish Lon : E 29 : 39.601
Length : 32.45 km

Transect # : 21

Start Lat : S 16 : 5.173 Start Lon : E 29 : 20.491
Finish Lat : S 16 : 5.173 Finish Lon : E 29 : 38.508
Length : 32.12 km

Transect # : 22

Start Lat : S 16 : 6.145 Start Lon : E 29 : 37.098
Finish Lat : S 16 : 6.145 Finish Lon : E 29 : 19.912
Length : 30.64 km

Transect # : 23

Start Lat : S 16 : 7.117 Start Lon : E 29 : 36.246
Finish Lat : S 16 : 7.117 Finish Lon : E 29 : 19.567
Length : 29.74 km

Transect # : 24B

Start Lat : S 16 : 8.089 Start Lon : E 29 : 19.222
Finish Lat : S 16 : 8.089 Finish Lon : E 29 : 20.001
Length : 1.39 km

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Transect # : 24A
Start Lat : S 16 : 8.089 Start Lon : E 29 : 21.655
Finish Lat : S 16 : 8.089 Finish Lon : E 29 : 35.976
Length : 25.54 km

Transect # : 25B
Start Lat : S 16 : 9.061 Start Lon : E 29 : 26.800
Finish Lat : S 16 : 9.061 Finish Lon : E 29 : 23.491
Length : 5.90 km

Transect # : 25D
Start Lat : S 16 : 9.061 Start Lon : E 29 : 36.197
Finish Lat : S 16 : 9.061 Finish Lon : E 29 : 31.127
Length : 9.04 km

Transect # : 25A
Start Lat : S 16 : 9.061 Start Lon : E 29 : 19.599
Finish Lat : S 16 : 9.061 Finish Lon : E 29 : 19.142
Length : 0.81 km

Transect # : 25C
Start Lat : S 16 : 9.061 Start Lon : E 29 : 29.907
Finish Lat : S 16 : 9.061 Finish Lon : E 29 : 29.684
Length : 0.40 km

Sapi North

Number of transects : 24
Transect Bearing : 0.00 Degrees
Transect Spacing : 1.50 km

Transect # : 1A
Start Lat : S 15 : 42.781 Start Lon : E 29 : 33.872
Finish Lat : S 15 : 42.198 Finish Lon : E 29 : 33.872
Length : 1.08 km

Transect # : 8
Start Lat : S 15 : 39.286 Start Lon : E 29 : 39.756
Finish Lat : S 15 : 44.274 Finish Lon : E 29 : 39.756
Length : 9.24 km

Transect # : 1B
Start Lat : S 15 : 41.819 Start Lon : E 29 : 33.872
Finish Lat : S 15 : 41.393 Finish Lon : E 29 : 33.872
Length : 0.79 km

Transect # : 9
Start Lat : S 15 : 44.080 Start Lon : E 29 : 40.596
Finish Lat : S 15 : 38.834 Finish Lon : E 29 : 40.596
Length : 9.72 km

Transect # : 2
Start Lat : S 15 : 39.286 Start Lon : E 29 : 34.713
Finish Lat : S 15 : 45.382 Finish Lon : E 29 : 34.713
Length : 11.29 km

Transect # : 10
Start Lat : S 15 : 38.517 Start Lon : E 29 : 41.437
Finish Lat : S 15 : 43.886 Finish Lon : E 29 : 41.437
Length : 9.94 km

Transect # : 3
Start Lat : S 15 : 45.400 Start Lon : E 29 : 35.553
Finish Lat : S 15 : 39.321 Finish Lon : E 29 : 35.553
Length : 11.26 km

Transect # : 11
Start Lat : S 15 : 43.692 Start Lon : E 29 : 42.277
Finish Lat : S 15 : 38.405 Finish Lon : E 29 : 42.277
Length : 9.79 km

Transect # : 4
Start Lat : S 15 : 39.709 Start Lon : E 29 : 36.394
Finish Lat : S 15 : 45.082 Finish Lon : E 29 : 36.394
Length : 9.95 km

Transect # : 12
Start Lat : S 15 : 38.293 Start Lon : E 29 : 43.118
Finish Lat : S 15 : 43.498 Finish Lon : E 29 : 43.118
Length : 9.64 km

Transect # : 5
Start Lat : S 15 : 44.856 Start Lon : E 29 : 37.234
Finish Lat : S 15 : 39.790 Finish Lon : E 29 : 37.234
Length : 9.38 km

Transect # : 13
Start Lat : S 15 : 43.275 Start Lon : E 29 : 43.958
Finish Lat : S 15 : 38.181 Finish Lon : E 29 : 43.958
Length : 9.43 km

Transect # : 6
Start Lat : S 15 : 39.781 Start Lon : E 29 : 38.075
Finish Lat : S 15 : 44.662 Finish Lon : E 29 : 38.075
Length : 9.04 km

Transect # : 14
Start Lat : S 15 : 38.049 Start Lon : E 29 : 44.799
Finish Lat : S 15 : 43.051 Finish Lon : E 29 : 44.799
Length : 9.26 km

Transect # : 7
Start Lat : S 15 : 44.468 Start Lon : E 29 : 38.915
Finish Lat : S 15 : 39.638 Finish Lon : E 29 : 38.915
Length : 8.95 km

Transect # : 15
Start Lat : S 15 : 42.828 Start Lon : E 29 : 45.639
Finish Lat : S 15 : 37.793 Finish Lon : E 29 : 45.639
Length : 9.32 km

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Transect # : 16
Start Lat : S 15 : 37.333 Start Lon : E 29 : 46.480
Finish Lat : S 15 : 42.604 Finish Lon : E 29 : 46.480
Length : 9.76 km

Transect # : 17
Start Lat : S 15 : 42.568 Start Lon : E 29 : 47.321
Finish Lat : S 15 : 37.072 Finish Lon : E 29 : 47.321
Length : 10.18 km

Transect # : 18
Start Lat : S 15 : 36.829 Start Lon : E 29 : 48.161
Finish Lat : S 15 : 42.378 Finish Lon : E 29 : 48.161
Length : 10.28 km

Transect # : 19
Start Lat : S 15 : 42.361 Start Lon : E 29 : 49.002
Finish Lat : S 15 : 36.665 Finish Lon : E 29 : 49.002
Length : 10.55 km

Transect # : 20
Start Lat : S 15 : 36.585 Start Lon : E 29 : 49.842
Finish Lat : S 15 : 42.415 Finish Lon : E 29 : 49.842
Length : 10.80 km

Transect # : 21
Start Lat : S 15 : 42.271 Start Lon : E 29 : 50.683
Finish Lat : S 15 : 36.671 Finish Lon : E 29 : 50.683
Length : 10.37 km

Transect # : 22A
Start Lat : S 15 : 36.757 Start Lon : E 29 : 51.523
Finish Lat : S 15 : 38.882 Finish Lon : E 29 : 51.523
Length : 3.93 km

Transect # : 22B
Start Lat : S 15 : 39.157 Start Lon : E 29 : 51.523
Finish Lat : S 15 : 39.647 Finish Lon : E 29 : 51.523
Length : 0.91 km

Transect # : 22C
Start Lat : S 15 : 40.509 Start Lon : E 29 : 51.523
Finish Lat : S 15 : 41.908 Finish Lon : E 29 : 51.523
Length : 2.59 km

Transect # : 23
Start Lat : S 15 : 38.202 Start Lon : E 29 : 52.364
Finish Lat : S 15 : 36.843 Finish Lon : E 29 : 52.364
Length : 2.52 km

Transect # : 24
Start Lat : S 15 : 37.034 Start Lon : E 29 : 53.204
Finish Lat : S 15 : 37.491 Finish Lon : E 29 : 53.204
Length : 0.85 km

Sapi South

Number of transects : 11

Transect Bearing : 90.00 Degrees

Transect Spacing : 3.60 km

Transect # : 1
Start Lat : S 15 : 42.903 Start Lon : E 29 : 45.355
Finish Lat : S 15 : 42.903 Finish Lon : E 29 : 50.502
Length : 9.18 km

Transect # : 3
Start Lat : S 15 : 44.847 Start Lon : E 29 : 50.069
Finish Lat : S 15 : 44.847 Finish Lon : E 29 : 37.273
Length : 22.82 km

Transect # : 5
Start Lat : S 15 : 46.791 Start Lon : E 29 : 34.981
Finish Lat : S 15 : 46.791 Finish Lon : E 29 : 50.291
Length : 27.30 km

Transect # : 7
Start Lat : S 15 : 48.735 Start Lon : E 29 : 48.820
Finish Lat : S 15 : 48.735 Finish Lon : E 29 : 35.966
Length : 22.92 km

Transect # : 9
Start Lat : S 15 : 50.679 Start Lon : E 29 : 35.216
Finish Lat : S 15 : 50.679 Finish Lon : E 29 : 48.031
Length : 22.85 km

Transect # : 11
Start Lat : S 15 : 52.623 Start Lon : E 29 : 47.512
Finish Lat : S 15 : 52.623 Finish Lon : E 29 : 34.659
Length : 22.92 km

Transect # : 13
Start Lat : S 15 : 54.567 Start Lon : E 29 : 34.957
Finish Lat : S 15 : 54.567 Finish Lon : E 29 : 46.993
Length : 21.46 km

Transect # : 15
Start Lat : S 15 : 56.511 Start Lon : E 29 : 46.474
Finish Lat : S 15 : 56.511 Finish Lon : E 29 : 34.862
Length : 20.70 km

Transect # : 17
Start Lat : S 15 : 58.455 Start Lon : E 29 : 34.634
Finish Lat : S 15 : 58.455 Finish Lon : E 29 : 45.955
Length : 20.18 km

Transect # : 19
Start Lat : S 16 : 0.399 Start Lon : E 29 : 46.354
Finish Lat : S 16 : 0.399 Finish Lon : E 29 : 33.993
Length : 22.04 km

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Transect # : 21A
Start Lat : S 16 : 2.343 Start Lon : E 29 : 32.856
Finish Lat : S 16 : 2.343 Finish Lon : E 29 : 38.077
Length : 9.31 km

Transect # : 21B
Start Lat : S 16 : 2.343 Start Lon : E 29 : 42.681
Finish Lat : S 16 : 2.343 Finish Lon : E 29 : 45.272
Length : 4.62 km

Chewore I

Number of transects : 13
Transect Bearing : 90.00 Degrees
Transect Spacing : 3.20 km

Transect # : 1
Start Lat : S 15 : 37.895 Start Lon : E 29 : 52.489
Finish Lat : S 15 : 37.895 Finish Lon : E 29 : 56.879
Length : 7.83 km

Transect # : 15
Start Lat : S 15 : 49.991 Start Lon : E 30 : 2.863
Finish Lat : S 15 : 49.991 Finish Lon : E 29 : 48.456
Length : 25.70 km

Transect # : 3
Start Lat : S 15 : 39.623 Start Lon : E 30 : 0.866
Finish Lat : S 15 : 39.623 Finish Lon : E 29 : 51.567
Length : 16.59 km

Transect # : 17
Start Lat : S 15 : 51.719 Start Lon : E 29 : 47.753
Finish Lat : S 15 : 51.719 Finish Lon : E 30 : 0.348
Length : 22.47 km

Transect # : 5
Start Lat : S 15 : 41.351 Start Lon : E 29 : 52.016
Finish Lat : S 15 : 41.351 Finish Lon : E 30 : 1.886
Length : 17.61 km

Transect # : 19B
Start Lat : S 15 : 53.447 Start Lon : E 29 : 58.221
Finish Lat : S 15 : 53.447 Finish Lon : E 29 : 55.829
Length : 4.27 km

Transect # : 7
Start Lat : S 15 : 43.079 Start Lon : E 30 : 3.527
Finish Lat : S 15 : 43.079 Finish Lon : E 29 : 50.482
Length : 23.27 km

Transect # : 19A
Start Lat : S 15 : 53.447 Start Lon : E 29 : 54.957
Finish Lat : S 15 : 53.447 Finish Lon : E 29 : 47.292
Length : 13.67 km

Transect # : 9
Start Lat : S 15 : 44.807 Start Lon : E 29 : 50.060
Finish Lat : S 15 : 44.807 Finish Lon : E 30 : 5.670
Length : 27.84 km

Transect # : 21
Start Lat : S 15 : 55.175 Start Lon : E 29 : 46.830
Finish Lat : S 15 : 55.175 Finish Lon : E 29 : 53.252
Length : 11.45 km

Transect # : 11
Start Lat : S 15 : 46.535 Start Lon : E 30 : 7.490
Finish Lat : S 15 : 46.535 Finish Lon : E 29 : 50.148
Length : 30.93 km

Transect # : 23
Start Lat : S 15 : 56.903 Start Lon : E 29 : 52.856
Finish Lat : S 15 : 56.903 Finish Lon : E 29 : 46.369
Length : 11.57 km

Transect # : 13A
Start Lat : S 15 : 48.263 Start Lon : E 29 : 49.184
Finish Lat : S 15 : 48.263 Finish Lon : E 30 : 5.192
Length : 28.55 km

Transect # : 25
Start Lat : S 15 : 58.631 Start Lon : E 29 : 45.908
Finish Lat : S 15 : 58.631 Finish Lon : E 29 : 51.705
Length : 10.34 km

Transect # : 13B
Start Lat : S 15 : 48.263 Start Lon : E 30 : 5.968
Finish Lat : S 15 : 48.263 Finish Lon : E 30 : 6.917
Length : 1.69 km

Chewore III

Number of transects : 12
Transect Bearing : 90.00 Degrees
Transect Spacing : 3.20 km

Transect # : 1
Start Lat : S 15 : 59.256 Start Lon : E 29 : 51.794
Finish Lat : S 15 : 59.256 Finish Lon : E 29 : 46.119
Length : 10.11 km

Transect # : 3
Start Lat : S 16 : 0.984 Start Lon : E 29 : 45.969
Finish Lat : S 16 : 0.984 Finish Lon : E 29 : 54.514
Length : 15.22 km

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Transect # : 5A
Start Lat : S 16 : 2.712 Start Lon : E 30 : 5.655
Finish Lat : S 16 : 2.712 Finish Lon : E 29 : 45.335
Length : 36.19 km

Transect # : 5B
Start Lat : S 16 : 2.712 Start Lon : E 29 : 42.914
Finish Lat : S 16 : 2.712 Finish Lon : E 29 : 41.934
Length : 1.74 km

Transect # : 7
Start Lat : S 16 : 4.440 Start Lon : E 29 : 41.926
Finish Lat : S 16 : 4.440 Finish Lon : E 30 : 5.977
Length : 42.84 km

Transect # : 9
Start Lat : S 16 : 6.168 Start Lon : E 30 : 4.776
Finish Lat : S 16 : 6.168 Finish Lon : E 29 : 41.612
Length : 41.26 km

Transect # : 11
Start Lat : S 16 : 7.896 Start Lon : E 29 : 41.639
Finish Lat : S 16 : 7.896 Finish Lon : E 30 : 6.212
Length : 43.77 km

Transect # : 13
Start Lat : S 16 : 9.624 Start Lon : E 30 : 6.779
Finish Lat : S 16 : 9.624 Finish Lon : E 29 : 44.360
Length : 39.93 km

Transect # : 15
Start Lat : S 16 : 11.352 Start Lon : E 29 : 47.467
Finish Lat : S 16 : 11.352 Finish Lon : E 30 : 8.085
Length : 36.72 km

Transect # : 17
Start Lat : S 16 : 13.080 Start Lon : E 30 : 6.486
Finish Lat : S 16 : 13.080 Finish Lon : E 29 : 51.109
Length : 27.39 km

Transect # : 19
Start Lat : S 16 : 14.808 Start Lon : E 29 : 56.371
Finish Lat : S 16 : 14.808 Finish Lon : E 30 : 5.559
Length : 16.37 km

Transect # : 21
Start Lat : S 16 : 16.536 Start Lon : E 30 : 5.733
Finish Lat : S 16 : 16.536 Finish Lon : E 30 : 3.087
Length : 4.71 km

Transect # : 23
Start Lat : S 16 : 18.264 Start Lon : E 30 : 5.255
Finish Lat : S 16 : 18.264 Finish Lon : E 30 : 5.430
Length : 0.31 km

Chapoto

Number of transects : 7

Transect Bearing : 90.00 Degrees

Transect Spacing : 3.70 km

Transect # : 1
Start Lat : S 15 : 38.646 Start Lon : E 30 : 23.669
Finish Lat : S 15 : 38.646 Finish Lon : E 30 : 25.309
Length : 2.92 km

Transect # : 2
Start Lat : S 15 : 40.644 Start Lon : E 30 : 25.313
Finish Lat : S 15 : 40.644 Finish Lon : E 30 : 18.232
Length : 12.63 km

Transect # : 3
Start Lat : S 15 : 42.642 Start Lon : E 30 : 18.896
Finish Lat : S 15 : 42.642 Finish Lon : E 30 : 25.316
Length : 11.45 km

Transect # : 4
Start Lat : S 15 : 44.640 Start Lon : E 30 : 25.319
Finish Lat : S 15 : 44.640 Finish Lon : E 30 : 21.081
Length : 7.6 km

Transect # : 5
Start Lat : S 15 : 46.638 Start Lon : E 30 : 21.256
Finish Lat : S 15 : 46.638 Finish Lon : E 30 : 25.312
Length : 7.2 km

Transect # : 6
Start Lat : S 15 : 48.636 Start Lon : E 30 : 25.306
Finish Lat : S 15 : 48.636 Finish Lon : E 30 : 16.255
Length : 16.14 km

Transect # : 7
Start Lat : S 15 : 50.634 Start Lon : E 30 : 16.633
Finish Lat : S 15 : 50.634 Finish Lon : E 30 : 22.098
Length : 9.75 km

Dande

Number of transects : 13
Transect Bearing : 0.00 Degrees
Transect Spacing : 3.20 km

Transect # : 1
Start Lat : S 16 : 0.559 Start Lon : E 30 : 25.433
Finish Lat : S 15 : 59.834 Finish Lon : E 30 : 25.433
Length : 1.34 km

Transect # : 3
Start Lat : S 15 : 50.367 Start Lon : E 30 : 23.637
Finish Lat : S 16 : 3.253 Finish Lon : E 30 : 23.637
Length : 23.86 km

Transect # : 5
Start Lat : S 16 : 2.681 Start Lon : E 30 : 21.841
Finish Lat : S 15 : 50.666 Finish Lon : E 30 : 21.841
Length : 22.25 km

Transect # : 7
Start Lat : S 15 : 51.025 Start Lon : E 30 : 20.046
Finish Lat : S 16 : 4.441 Finish Lon : E 30 : 20.046
Length : 24.84 km

Transect # : 9
Start Lat : S 16 : 6.835 Start Lon : E 30 : 18.250
Finish Lat : S 15 : 50.811 Finish Lon : E 30 : 18.250
Length : 29.68 km

Transect # : 11
Start Lat : S 15 : 50.587 Start Lon : E 30 : 16.454
Finish Lat : S 16 : 7.969 Finish Lon : E 30 : 16.454
Length : 32.19 km

Transect # : 13
Start Lat : S 16 : 9.196 Start Lon : E 30 : 14.659
Finish Lat : S 15 : 50.070 Finish Lon : E 30 : 14.659
Length : 35.42 km

Transect # : 15
Start Lat : S 15 : 51.752 Start Lon : E 30 : 12.863
Finish Lat : S 16 : 9.364 Finish Lon : E 30 : 12.863
Length : 32.62 km

Transect # : 17
Start Lat : S 16 : 9.107 Start Lon : E 30 : 11.067
Finish Lat : S 15 : 53.434 Finish Lon : E 30 : 11.067
Length : 29.02 km

Transect # : 19
Start Lat : S 15 : 55.116 Start Lon : E 30 : 9.272
Finish Lat : S 16 : 9.356 Finish Lon : E 30 : 9.272
Length : 26.37 km

Transect # : 21
Start Lat : S 16 : 10.495 Start Lon : E 30 : 7.476
Finish Lat : S 15 : 56.422 Finish Lon : E 30 : 7.476
Length : 26.06 km

Transect # : 23A
Start Lat : S 15 : 57.671 Start Lon : E 30 : 5.680
Finish Lat : S 16 : 2.195 Finish Lon : E 30 : 5.680
Length : 8.38 km

Transect # : 23B
Start Lat : S 16 : 2.693 Start Lon : E 30 : 5.680
Finish Lat : S 16 : 2.749 Finish Lon : E 30 : 5.680
Length : 0.10 km

Transect # : 23C
Start Lat : S 16 : 4.587 Start Lon : E 30 : 5.680
Finish Lat : S 16 : 7.464 Finish Lon : E 30 : 5.680
Length : 5.33 km

Transect # : 25
Start Lat : S 16 : 1.488 Start Lon : E 30 : 3.885
Finish Lat : S 15 : 58.921 Finish Lon : E 30 : 3.885
Length : 4.76 km

Kanyurira

Number of transects : 5
Transect Bearing : 90.00 Degrees
Transect Spacing : 3.00 km

Transect # : 1A
Start Lat : S 16 : 9.838 Start Lon : E 30 : 16.115
Finish Lat : S 16 : 9.838 Finish Lon : E 30 : 16.105
Length : 0.02 km

Transect # : 1B
Start Lat : S 16 : 9.838 Start Lon : E 30 : 15.911
Finish Lat : S 16 : 9.838 Finish Lon : E 30 : 8.240
Length : 13.65 km

Transect # : 2
Start Lat : S 16 : 11.458 Start Lon : E 30 : 7.863
Finish Lat : S 16 : 11.458 Finish Lon : E 30 : 16.055
Length : 14.58 km

Transect # : 3
Start Lat : S 16 : 13.078 Start Lon : E 30 : 15.909
Finish Lat : S 16 : 13.078 Finish Lon : E 30 : 6.488
Length : 16.76 km

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Transect # : 4
Start Lat : S 16 : 14.698 Start Lon : E 30 : 5.544
Finish Lat : S 16 : 14.698 Finish Lon : E 30 : 15.844
Length : 18.33 km

Transect # : 5
Start Lat : S 16 : 16.318 Start Lon : E 30 : 12.035
Finish Lat : S 16 : 16.318 Finish Lon : E 30 : 5.702
Length : 11.27 km

Chisunga

Number of transects : 7
Transect Bearing : 90.00 Degrees
Transect Spacing : 5.70 km

Transect # : 1
Start Lat : S 15 : 59.988 Start Lon : E 30 : 26.539
Finish Lat : S 15 : 59.988 Finish Lon : E 30 : 32.743
Length : 11.05 km

Transect # : 5A
Start Lat : S 16 : 12.300 Start Lon : E 30 : 16.230
Finish Lat : S 16 : 12.300 Finish Lon : E 30 : 29.360
Length : 23.38 km

Transect # : 2A
Start Lat : S 16 : 3.066 Start Lon : E 30 : 35.641
Finish Lat : S 16 : 3.066 Finish Lon : E 30 : 35.340
Length : 0.54 km

Transect # : 5B
Start Lat : S 16 : 12.300 Start Lon : E 30 : 29.702
Finish Lat : S 16 : 12.300 Finish Lon : E 30 : 29.750
Length : 0.09 km

Transect # : 2B
Start Lat : S 16 : 3.066 Start Lon : E 30 : 33.763
Finish Lat : S 16 : 3.066 Finish Lon : E 30 : 24.006
Length : 17.37 km

Transect # : 5C
Start Lat : S 16 : 12.300 Start Lon : E 30 : 30.786
Finish Lat : S 16 : 12.300 Finish Lon : E 30 : 31.078
Length : 0.52 km

Transect # : 2C
Start Lat : S 16 : 3.066 Start Lon : E 30 : 22.549
Finish Lat : S 16 : 3.066 Finish Lon : E 30 : 21.043
Length : 2.68 km

Transect # : 6A
Start Lat : S 16 : 15.378 Start Lon : E 30 : 26.594
Finish Lat : S 16 : 15.378 Finish Lon : E 30 : 17.063
Length : 16.97 km

Transect # : 3
Start Lat : S 16 : 6.144 Start Lon : E 30 : 18.797
Finish Lat : S 16 : 6.144 Finish Lon : E 30 : 34.661
Length : 28.25 km

Transect # : 6B
Start Lat : S 16 : 15.378 Start Lon : E 30 : 16.307
Finish Lat : S 16 : 15.378 Finish Lon : E 30 : 15.579
Length : 1.30 km

Transect # : 4
Start Lat : S 16 : 9.222 Start Lon : E 30 : 33.425
Finish Lat : S 16 : 9.222 Finish Lon : E 30 : 15.979
Length : 31.06 km

Transect # : 7
Start Lat : S 16 : 18.456 Start Lon : E 30 : 18.487
Finish Lat : S 16 : 18.456 Finish Lon : E 30 : 21.460
Length : 5.29 km

Kadze West

Number of transects : 6
Transect Bearing : 90.00 Degrees
Transect Spacing : 4.60 km

Transect # : 1
Start Lat : S 16 : 0.602 Start Lon : E 30 : 32.669
Finish Lat : S 16 : 0.602 Finish Lon : E 30 : 48.000
Length : 27.29 km

Transect # : 3
Start Lat : S 16 : 5.570 Start Lon : E 30 : 35.022
Finish Lat : S 16 : 5.570 Finish Lon : E 30 : 48.000
Length : 23.10 km

Transect # : 2A
Start Lat : S 16 : 3.086 Start Lon : E 30 : 48.000
Finish Lat : S 16 : 3.086 Finish Lon : E 30 : 35.693
Length : 21.91 km

Transect # : 4
Start Lat : S 16 : 8.054 Start Lon : E 30 : 48.000
Finish Lat : S 16 : 8.054 Finish Lon : E 30 : 33.769
Length : 25.34 km

Transect # : 2B
Start Lat : S 16 : 3.086 Start Lon : E 30 : 35.310
Finish Lat : S 16 : 3.086 Finish Lon : E 30 : 33.784
Length : 2.72 km

Transect # : 5A
Start Lat : S 16 : 10.538 Start Lon : E 30 : 33.249
Finish Lat : S 16 : 10.538 Finish Lon : E 30 : 33.640
Length : 0.70 km

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Transect # : 5B
Start Lat : S 16 : 10.538 Start Lon : E 30 : 36.657
Finish Lat : S 16 : 10.538 Finish Lon : E 30 : 48.000
Length : 20.19 km

Transect # : 6
Start Lat : S 16 : 13.022 Start Lon : E 30 : 48.000
Finish Lat : S 16 : 13.022 Finish Lon : E 30 : 40.632
Length : 13.12 km

Kadze East

Number of transects : 7
Transect Bearing : 90.00 Degrees
Transect Spacing : 4.60 km

Transect # : 1
Start Lat : S 16 : 15.539 Start Lon : E 30 : 48.821
Finish Lat : S 16 : 15.539 Finish Lon : E 30 : 58.260
Length : 16.81 km

Transect # : 6A
Start Lat : S 16 : 3.119 Start Lon : E 31 : 8.508
Finish Lat : S 16 : 3.119 Finish Lon : E 31 : 7.805
Length : 1.25 km

Transect # : 2
Start Lat : S 16 : 13.055 Start Lon : E 30 : 58.604
Finish Lat : S 16 : 13.055 Finish Lon : E 30 : 48.000
Length : 18.88 km

Transect # : 6B
Start Lat : S 16 : 3.119 Start Lon : E 31 : 7.306
Finish Lat : S 16 : 3.119 Finish Lon : E 31 : 0.745
Length : 11.68 km

Transect # : 3
Start Lat : S 16 : 10.571 Start Lon : E 30 : 48.000
Finish Lat : S 16 : 10.571 Finish Lon : E 31 : 0.374
Length : 22.03 km

Transect # : 6C
Start Lat : S 16 : 3.119 Start Lon : E 30 : 58.390
Finish Lat : S 16 : 3.119 Finish Lon : E 30 : 58.328
Length : 0.11 km

Transect # : 4A
Start Lat : S 16 : 8.087 Start Lon : E 31 : 6.956
Finish Lat : S 16 : 8.087 Finish Lon : E 31 : 5.444
Length : 2.69 km

Transect # : 6D
Start Lat : S 16 : 3.119 Start Lon : E 30 : 58.255
Finish Lat : S 16 : 3.119 Finish Lon : E 30 : 48.000
Length : 18.26 km

Transect # : 4B
Start Lat : S 16 : 8.087 Start Lon : E 31 : 5.052
Finish Lat : S 16 : 8.087 Finish Lon : E 30 : 48.000
Length : 30.36 km

Transect # : 7
Start Lat : S 16 : 0.635 Start Lon : E 30 : 48.000
Finish Lat : S 16 : 0.635 Finish Lon : E 30 : 56.445
Length : 15.04 km

Transect # : 5
Start Lat : S 16 : 5.603 Start Lon : E 30 : 48.000
Finish Lat : S 16 : 5.603 Finish Lon : E 31 : 8.153
Length : 35.89 km

Appendix 4. Transect summaries of sightings

Species codes:

Code	Species
Bab	Baboon
Buff	Buffalo
Catt	Cattle
Croc	Crocodile
Dkr	Common or Bush Duiker
Donk	Donkey
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
Hipo	Hippopotamus
Imp	Impala
Kudu	Kudu
PC	Poachers' camp
Sab	Sable antelope
Shoa	Sheep and/or goats
UnCa	Unidentified carcass
Wbk	Waterbuck
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 the search strips

The following tables list, for each transect stratum, the number of individuals of each species that were seen inside the right search strip on each transect. For each block count stratum, the tables list the number of individuals of each species that were seen inside the blocks.

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 21/08/14
 Stratum Locality : Zambezi Valley
 Stratum Area : 615 sq km
 N : 227 n : 16
 Pilot : Charles Mackie

Stratum Name : Rifa
 Base Line Length : 36.9 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.131
 Observers : Douglas Kuramba, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	ElC4	Buff	Zeb	Imp	Kudu	Hipo	Bab
1	1	0	0	0	0	0	0	0	0
2	0	32	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	2	0
4	0	0	0	0	0	0	0	0	0
5	0	4	1	0	0	10	0	0	0
6	10	4	1	0	0	2	2	0	0
7	0	2	0	0	0	15	0	0	0
8	2	0	2	0	2	0	0	0	0
9	1	5	0	32	0	0	4	0	0
10	0	15	0	0	0	0	0	0	0
11	0	0	0	43	0	0	0	0	1
12	0	0	0	0	0	0	0	6	0
13	0	0	1	0	0	20	0	0	0
14	0	0	0	0	0	0	0	0	0
15	0	2	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	ElC4	Buff	Zeb	Imp	Kudu	Hipo	Bab
	14	64	5	75	2	47	6	8	1

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 21-22/08/2014
 Stratum Locality : Zambezi Valley
 Stratum Area : 1208 sq km
 N : 355 n : 39
 Pilot : Charles Mackie

Stratum Name : Hurungwe
 Base Line Length : 57.6 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.024
 Observers : Douglas Kurumba, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC4	UnCa	Buff	Zeb	Imp	Whog	Kudu	Eld	Hipo	Bab	Croc
1	0	0	0	0	0	0	0	0	0	0	0	0	0
2	8	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	4	0	0
4	0	5	0	0	0	0	0	0	0	0	0	0	0
5	0	0	1	0	0	0	17	0	0	0	18	0	0
6	5	0	0	0	0	0	8	0	0	0	0	0	0
7	2	0	0	0	0	0	0	0	0	0	3	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9	1	0	1	0	0	0	0	0	0	0	0	0	0
10	3	0	1	0	0	0	0	0	0	0	0	3	0
11	0	0	1	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	1
13	0	0	1	0	0	0	0	0	0	0	0	0	0
14	1	4	0	0	0	0	0	0	2	0	0	0	0
15	1	0	1	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	5	0	0	0	0	0	0
17	11	20	1	0	0	0	0	0	0	0	2	0	0
18	0	9	0	0	0	0	0	0	0	0	0	0	0
19	0	1	1	0	0	0	14	0	0	0	0	0	0
20	5	6	1	0	0	0	12	0	1	0	0	0	0
21	1	15	1	1	0	2	29	0	0	0	4	0	0
22	2	4	0	0	15	1	0	8	0	0	0	0	0
23	2	0	0	0	0	0	16	0	0	0	0	0	0
24	3	22	0	0	50	0	6	0	0	0	0	0	0
25	0	5	0	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	2	0	0	0	0	0	0	0
27	0	0	0	0	10	0	0	0	0	0	0	0	0
28	0	0	1	0	0	0	0	0	0	0	0	0	0
29	0	0	1	0	0	0	0	0	0	0	0	0	0
30	0	6	1	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	1	0	0	0
32	0	0	0	0	0	0	0	1	0	0	0	0	0
33	1	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	1	0	0	0	0	0	0	0	0	0
35	1	0	0	0	0	0	0	0	0	0	0	0	0
36	1	0	0	0	0	0	0	0	0	0	0	0	0
37	0	2	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC4	UnCa	Buff	Zeb	Imp	Whog	Kudu	Eld	Hipo	Bab	Croc
	49	99	13	2	75	5	107	9	3	1	31	3	1

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 25/08/14
 Stratum Locality : Zambezi Valley
 Stratum Area : 319 sq km
 N : 294 n : 32
 Pilot : Charles Mackie

Stratum Name : Mana I
 Base Line Length : 48.2 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.04
 Observers : Douglas Kuramba, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	ElC4	Buff	Zeb	Wbk	Imp	Whog	Kudu	Ghb	Eld	Hipo	Bab	Croc
1	0	0	0	0	0	0	0	0	0	0	0	4	0	0
2	0	0	0	0	0	0	0	0	0	0	0	15	0	4
3	0	4	0	2	0	0	2	0	0	0	0	0	0	0
4	0	0	0	0	4	6	0	0	0	0	0	25	0	1
5	0	0	1	0	0	6	25	0	0	0	0	0	0	2
6	0	0	0	85	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	2	0	0	0	0	0	0	0
8	0	0	0	0	0	1	0	0	0	0	0	8	0	0
9	0	0	0	0	0	15	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	10	0	0	0	0	0	0	2
12	0	0	0	0	0	0	0	0	0	0	0	3	0	0
13	1	0	0	0	0	0	17	0	0	0	0	1	0	2
14	0	10	0	0	0	0	1	0	0	0	0	4	0	0
15	0	0	0	0	4	0	18	6	0	0	4	15	0	0
16	0	0	0	0	0	0	4	0	0	0	3	8	0	15
17	0	0	0	0	0	0	10	0	0	0	0	1	0	0
18	5	0	0	8	0	0	0	0	0	0	0	23	4	0
19	0	0	0	3	0	0	0	0	2	3	0	15	0	6
20	1	0	0	0	0	0	11	3	0	0	0	25	0	1
21	0	0	0	2	0	0	0	0	0	0	0	2	0	0
22	0	9	0	0	0	0	0	0	0	0	8	9	0	1
23	2	18	0	0	0	0	0	3	0	0	0	0	0	4
24	0	0	0	0	0	0	18	0	0	0	0	4	0	1
25	3	0	0	0	0	0	0	0	0	0	0	30	0	4
26	0	0	0	0	0	4	3	0	0	0	0	0	0	1
27	0	2	0	0	0	0	0	0	0	0	0	18	0	0
28	15	15	0	0	0	0	0	0	0	0	0	2	0	0
29	0	0	1	0	0	0	0	0	0	0	0	12	0	0
30	4	4	0	0	0	0	0	0	0	0	0	0	0	0
31	1	3	0	0	0	8	0	0	0	0	0	2	0	0
32	1	0	0	0	0	2	0	0	0	0	0	8	0	0

Sighting Totals

	EleM	EleF	ElC4	Buff	Zeb	Wbk	Imp	Whog	Kudu	Ghb	Eld	Hipo	Bab	Croc
	33	65	2	100	8	42	121	12	2	3	15	234	4	44

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 23,31/08/2014
 Stratum Locality : Zambezi Valley
 Stratum Area : 1388 sq km
 N : 273 n : 22
 Pilot : Charles Mackie

Stratum Name : Mana II
 Base Line Length : 44.9 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.08
 Observers : Douglas Kuramba, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC3	EIC4	Buff	Zeb	Imp	Kudu	Bab
1	0	0	0	1	0	0	0	0	0
2	9	0	0	1	35	0	0	0	0
3	4	0	0	0	0	0	0	0	0
4	0	14	0	1	5	0	0	0	5
5	5	5	0	0	2	0	0	0	0
6	1	18	1	1	0	0	8	0	1
7	1	0	0	0	0	0	0	0	0
8	1	0	0	0	0	4	0	0	0
9	0	0	0	0	0	0	0	0	0
10	1	8	0	1	0	0	0	0	0
11	0	8	0	0	0	0	0	0	0
12	2	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
17	1	0	0	0	0	0	0	0	0
19	0	12	0	0	0	0	0	0	0
20	5	7	0	3	0	0	6	0	0
21	0	0	0	0	30	0	7	0	0
22	1	7	0	1	100	0	42	0	0
23	6	6	0	0	0	0	0	0	0
24	13	7	0	2	0	0	20	0	0
25	3	8	0	0	36	0	0	2	0

Sighting Totals

	EleM	EleF	EIC3	EIC4	Buff	Zeb	Imp	Kudu	Bab
	53	100	1	11	208	4	83	2	6

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 25&27/08/2014
 Stratum Locality : Zambezi Valley
 Stratum Area : 316 sq km
 N : 220 n : 24
 Pilot : Charles Mackie

Stratum Name : Sapi North
 Base Line Length : 35.7 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.069
 Observers : Douglas Kuramba, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC4	Wbk	Imp	Whog	Kudu	Hipo	Bab	Croc
1	0	2	0	0	0	0	0	0	0	0
2	2	9	0	3	0	0	0	1	0	1
3	1	10	1	1	2	0	0	0	0	1
4	2	8	0	0	0	0	0	0	0	2
5	1	0	0	0	3	0	0	0	0	0
6	0	0	0	0	0	0	2	0	0	0
7	0	2	0	0	0	0	0	0	4	0
8	1	0	0	0	0	0	0	8	0	1
9	1	0	0	0	0	0	0	0	0	0
10	1	2	0	0	0	0	0	1	0	0
11	0	0	0	0	0	0	0	14	0	2
12	0	0	0	0	0	0	1	0	0	1
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	2	0	2
17	0	0	0	0	0	0	0	5	0	0
18	0	0	0	5	0	0	0	0	0	3
19	1	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	5	0
22	3	0	1	0	0	0	1	0	0	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC4	Wbk	Imp	Whog	Kudu	Hipo	Bab	Croc
	13	33	2	9	5	0	4	31	9	13

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 27-28/08/2014
 Stratum Locality : Zambezi Valley
 Stratum Area : 796 sq km
 N : 236 n : 11
 Pilot : Charles Mackie

Stratum Name : Sapi South
 Base Line Length : 38.8 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.228
 Observers : Douglas Kurumba, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	ElC4	Sab	Whog	Dkr
1	0	0	0	0	0	0
3	0	0	0	0	0	0
5	0	0	0	2	0	0
7	0	0	0	0	0	0
9	0	0	0	0	0	1
11	1	6	0	0	0	0
13	0	0	1	0	1	0
15	0	0	1	0	0	0
17	0	0	0	0	0	0
19	0	0	0	0	0	0
21	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	ElC4	Sab	Whog	Dkr
	1	6	2	2	1	1

Date of Survey : 28/08/14
 Stratum Locality : Zambezi Valley
 Stratum Area : 796 sq km
 N : 249 n : 13
 Pilot : Charles Mackie

Stratum Name : Chewore I
 Base Line Length : 39.6 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.179
 Observers : Douglas Kurumba, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	ElC4	Buff	Zeb	Imp	Kudu
1	0	0	0	0	0	0	0
3	1	0	1	0	0	0	0
5	2	6	0	0	0	0	0
7	1	3	1	0	0	0	0
9	11	13	1	0	0	0	0
11	1	0	0	0	0	0	0
13	0	7	0	0	0	3	0
15	0	11	0	36	4	0	0
17	0	8	0	0	0	0	0
19	0	9	0	0	0	0	0
21	2	0	1	0	0	0	0
23	1	0	0	0	0	0	1
25	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	ElC4	Buff	Zeb	Imp	Kudu
	19	57	4	36	4	3	1

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 29/08/14
 Stratum Locality : Zambezi Valley
 Stratum Area : 977 sq km
 N : 217 n : 12
 Pilot : Charles Mackie

Stratum Name : Chewore III
 Base Line Length : 37 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.201
 Observers : Douglas Kuramba, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC4	Zeb	Imp
1	0	0	0	0	0
3	0	0	0	0	0
5	0	3	0	8	1
7	0	10	0	0	0
9	1	17	0	0	0
11	4	4	0	0	0
13	1	8	2	0	0
15	0	10	2	0	0
17	0	0	0	0	0
19	0	8	0	0	0
21	0	0	0	0	0
23	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC4	Zeb	Imp
	6	60	4	8	1

Date of Survey : 30/08/14
 Stratum Locality : Zambezi Valley
 Stratum Area : 991 sq km
 N : 243 n : 13
 Pilot : Charles Mackie

Stratum Name : Dande
 Base Line Length : 40.7 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.179
 Observers : Douglas Kuramba, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC4	Whog	Kudu	Catt	Shoa
1	0	0	0	0	0	3	0
3	0	5	0	0	0	0	0
5	0	0	0	0	0	0	0
7	1	4	0	0	0	0	8
9	0	0	0	0	0	0	21
11	0	0	1	2	0	0	0
13	0	31	1	0	1	0	0
15	0	0	1	0	0	0	0
17	0	15	0	3	0	0	0
19	0	0	0	0	0	0	0
21	0	0	2	0	0	0	0
23	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0

Sighting Totals

	EleM	EleF	EIC4	Whog	Kudu	Catt	Shoa
	1	55	5	5	1	3	29

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 30/08/14

Stratum Locality : Zambezi Valley

Stratum Area : 282 sq km

N : 143 n : 7

Pilot : Charles Mackie

Stratum Name : Chapoto

Base Line Length : 25.1 km

Calibrated Strip Width at 300 ft : 162 m

t : 2.447

Observers : Douglas Kuramba, Greg Nyaguse

Transect summary table :

T #	EleF	Shoa	Dkr
1	0	0	0
2	0	0	0
3	0	24	1
4	0	10	0
5	0	0	0
6	18	0	0
7	0	0	0

Sighting Totals

	EleF	Shoa	Dkr
	18	34	1

Date of Survey : 27/08/14

Stratum Locality : Zambezi Valley

Stratum Area : 759 sq km

N : 213 n : 7

Pilot : Charles Mackie

Stratum Name : Chisunga

Base Line Length : 36.6 km

Calibrated Strip Width at 300 ft : 162 m

t : 2.447

Observers : Douglas Kuramba, Greg Nyaguse

Transect summary table :

T #	Cattle	Shoat
1	0	8
2	48	8
3	28	46
4	11	39
5	34	15
6	3	0
7	0	0

Sighting Totals

	Cattle	Shoat
	124	116

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 31/08/14
 Stratum Locality : Zambezi Valley
 Stratum Area : 207 sq km
 N : 87 n : 5
 Pilot : Charles Mackie

Stratum Name : Kanyurira
 Base Line Length : 14.6 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.776
 Observers : Douglas Kuramba, Greg Nyaguse

Transect summary table :

T #	EleM	EleF	EIC4	Wbk	Shoa
1	0	0	0	0	8
2	0	0	0	1	12
3	0	0	0	0	0
4	4	17	0	0	0
5	0	0	1	0	0

Sighting Totals

	EleM	EleF	EIC4	Wbk	Shoa
	4	17	1	1	20

Date of Survey : 28/08/14
 Stratum Locality : Zambezi Valley
 Stratum Area : 592 sq km
 N : 171 n : 6
 Pilot : Charles Mackie

Stratum Name : Kadze West
 Base Line Length : 28.5 km
 Calibrated Strip Width at 300 ft : 162 m
 t : 2.571
 Observers : Douglas Kuramba, Greg Nyaguse

Transect summary table :

T #	Whog	Catt	Shoa
1	1	11	15
2	0	16	0
3	0	21	8
4	0	32	31
5	0	14	2
6	0	3	0

Sighting Totals

	Whog	Catt	Shoa
	1	97	56

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 29/08/14

Stratum Locality : Zambezi Valley

Stratum Area : 779 sq km

N : 189 n : 7

Pilot : Charles Mackie

Stratum Name : Kadze East

Base Line Length : 30.9 km

Calibrated Strip Width at 300 ft : 162 m

t : 2.447

Observers : Douglas Kurumba, Greg Nyaguse

Transect summary table :

T #	Zeb	Kudu	Catt	Shoa
1	0	0	47	12
2	0	0	33	2
3	0	0	34	16
4	0	0	231	158
5	5	0	21	20
6	0	0	39	24
7	0	3	0	0

Sighting Totals

	Zeb	Kudu	Catt	Shoa
	5	3	405	232

Date of Survey : 27/06/14

Stratum Locality : Zambezi Valley

Stratum Area : 929 sq km

n (sampled) : 8 n (searched) : 8

Pilot : M. Henriksen

Stratum Name : South Charara

t : 2.365

Recorder/Observer : K. Dunham

Block summary table :

	Number	Time (mins)	Area (sq km)	Zeb	Sab	Catt
1	65	19	15.2	0	0	0
2	45	17	9.8	0	0	0
3	69	22	14.0	0	9	0
4	17	16	22.1	0	0	16
5	38	6	8.1	0	0	0
6	47	25	17.5	0	0	0
7	40	15	17.5	0	0	0
8	41	25	13.7	2	0	0

Sighting Totals:

	Zeb	Sab	Catt
	2	9	16

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 28/06/14

Stratum Name : North Charara

Stratum Locality : Zambezi Valley

Stratum Area : 733 sq km

n (sampled) : 8

n (searched) : 8

t : 2.365

Pilot : M. Henriksen

Recorder/Observer : K. Dunham

Block summary table :

	Number	Time (mins)	Area (sq km)	EleM	EIC2	EIC3	EIC4	UnCa	Imp	PC	Hipo
1	57	10	17.2	3	0	0	0	0	0	0	0
2	33	18	18.2	0	0	0	0	0	0	0	0
3	43	12	6.8	0	1	0	0	1	0	1	0
4	21	23	19.9	0	0	0	0	0	0	0	0
5	44	17	18.0	4	0	0	0	0	0	0	0
6	46	22	17.0	0	0	1	1	1	0	0	21
7	24	24	19.4	0	0	0	0	0	3	0	0
8	28	20	16.7	0	0	0	0	0	0	0	0

Sighting Totals:

				EleM	EIC2	EIC3	EIC4	UnCa	Imp	PC	Hipo
				7	1	1	1	2	3	1	21

Date of Survey : 29/06/14

Stratum Name : Hurungwe I

Stratum Locality : Zambezi Valley

Stratum Area : 673 sq km

n (sampled) : 10

n (searched) : 10

t : 2.262

Pilot : M. Henriksen

Recorder/Observer : K. Dunham

Block summary table :

	Number	Time (mins)	Area (sq km)	EleM	EleF	Buff	Imp	Kudu
1	11	12	10.3	0	0	0	0	1
2	22	14	12.3	0	0	0	0	0
3	52	11	7.6	3	0	0	0	0
4	42	18	18.4	0	16	0	0	0
5	19	10	11.7	0	0	0	0	0
6	7	13	16.9	0	0	0	12	0
7	6	24	20.6	0	0	80	0	0
8	37	5	6.0	0	0	0	0	0
9	8	11	9.7	0	0	0	0	0
10	54	19	18.5	0	0	0	0	0

Sighting Totals:

				EleM	EleF	Buff	Imp	Kudu
				3	16	80	12	1

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 30 June - 1 July 2014

Stratum Name : Marongora (Hurungwe II)

Stratum Locality : Zambezi Valley

Stratum Area : 524 sq km

n (sampled) : 10 n (searched) : 9

t : 2.262

Pilot : M. Henriksen

Recorder/Observer : K. Dunham / G. Nyaguse

Block summary table :

	Number	Time (mins)	Area (sq km)	EleM	EleF	EIC4	Buff	Zeb
1	23	10	8.6	0	0	0	0	0
2	27	24	20.9	0	0	0	0	0
3	14	17	14.0	0	5	0	0	0
4	10	16	14.0	0	0	0	0	0
5	38	22	18.6	4	30	0	50	0
6	17	14	16.6	2	0	1	0	0
7	40	12	9.0	1	0	0	0	4
8	30	7	4.5	0	0	0	0	0
9	17							
10	12	24	18.0	0	4	0	0	4

Sighting Totals:

				EleM	EleF	EIC4	Buff	Zeb
				7	39	1	50	8

Date of Survey : 01/07/14

Stratum Name : Mana Escarpment

Stratum Locality : Zambezi Valley

Stratum Area : 462 sq km

n (sampled) : 6 n (searched) : 6

t : 2.571

Pilot : M. Henriksen

Recorder/Observer : G. Nyaguse

Block summary table :

	Number	Time (mins)	Area (sq km)	EleM	EleF	Buff
1	5	18	16.0	8	0	0
2	18	13	8.5	0	4	0
3	27	15	15.8	0	0	0
4	34	12	10.6	0	0	0
5	24	17	10.8	0	0	0
6	1	13	12.8	11	16	5

Sighting Totals:

				EleM	EleF	Buff
				19	20	5

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 03/07/14

Stratum Name : Chewore IV Escarpment

Stratum Locality : Zambezi Valley

Stratum Area : 472 sq km

n (sampled) : 13

n (searched) : 11

t : 2.179

Pilot : M. Henriksen

Recorder/Observer : G. Nyaguse

Block summary table :

	Number	Time (mins)	Area (sq km)
1	38	7	6.2
2	22	9	10.4
3	49	14	14.1
4	31	9	4.2
5	43	11	10.3
6	49		
7	41	11	8.1
8	3	9	7.0
9	50	10	9.1
10	26	9	6.5
11	25	12	7.8
12	35	13	12.5
13	3		

Sighting Totals:

No large herbivores or elephant carcasses seen in the search blocks

Date of Survey : 04/07/14

Stratum Name : Mukwiche

Stratum Locality : Zambezi Valley

Stratum Area : 337 sq km

n (sampled) : 11

n (searched) : 8

t : 2.228

Pilot : M. Henriksen

Recorder/Observer : G. Nyaguse

Block summary table :

	Number	Time (mins)	Area (sq km)
1	42	5	3.0
2	37	8	6.2
3	18	11	6.9
4	14	17	13.2
5	15	16	12.5
6	15		
7	15		
8	24	16	11.9
9	11	12	7.3
10	42		
11	8	18	13.9

Sighting Totals:

No large herbivores or elephant carcasses seen in the search blocks

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 5-7 July 2014

Stratum Name : Chewore II Hills

Stratum Locality : Zambezi Valley

Stratum Area : 1058 sq km

n (sampled) : 19 n (searched) : 17

t : 2.101

Pilot : M. Henriksen

Recorder/Observer : G. Nyaguse

Block summary table :

	Number	Time (mins)	Area (sq km)	EleM	EleF	EIC4	Zeb	Sab	Imp	Whog	Kudu	Ghb
1	92	22	23.3	0	38	0	0	0	0	0	0	0
2	66	13	9.8	0	0	0	0	0	0	0	0	0
3	52	6	8.8	0	0	0	0	0	0	0	0	0
4	34	18	17.4	0	12	0	0	0	0	0	0	0
5	73	19	18.5	0	0	0	0	0	0	0	0	0
6	84	13	11.5	0	0	0	0	0	0	0	0	0
7	94	23	21.0	1	26	0	0	0	0	0	0	0
8	28	21	10.5	3	4	0	0	0	18	0	7	0
9	23	15	9.1	5	0	0	0	1	0	0	0	0
10	11	19	20.2	0	0	0	0	0	0	0	0	0
11	94											
12	12	11	4.8	0	0	0	0	0	0	0	0	0
13	76	18	12.5	0	0	0	12	0	0	0	0	2
14	74	11	6.4	0	0	0	0	0	0	0	0	0
15	95	32	25.3	0	19	1	0	0	28	2	0	0
16	34											
17	35	14	13.2	0	0	0	0	0	0	0	0	0
18	53	14	7.4	1	8	0	0	0	0	0	0	0
19	50	18	10.0	0	19	1	0	0	0	0	0	0

Sighting Totals:

				EleM	EleF	EIC4	Zeb	Sab	Imp	Whog	Kudu	Ghb
				10	126	2	12	1	46	2	7	2

Date of Survey : 07/07/14

Stratum Name : Kanyurira Highlands

Stratum Locality : Zambezi Valley

Stratum Area : 147 sq km

n (sampled) : 6 n (searched) : 5

t : 2.571

Pilot : M. Henriksen

Recorder/Observer : G. Nyaguse

Block summary table :

	Number	Time (mins)	Area (sq km)	EleF	EIC4	Zeb	Sab	Whog
1	9	12	10.8	0	0	0	0	0
2	5	18	12.7	4	2	5	0	0
3	11	7	6.8	0	0	0	0	0
4	6	13	9.2	6	0	0	7	0
5	1	16	11.2	8	0	0	0	1
6	6							

Sighting Totals:

				EleF	EIC4	Zeb	Sab	Whog
				18	2	5	7	1

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 09/07/14

Stratum Name : Doma

Stratum Locality : Zambezi Valley

Stratum Area : 991 sq km

n (sampled) : 14

n (searched) : 12

t : 2.16

Pilot : M. Henriksen

Recorder/Observer : G. Nyaguse

Block summary table :

	Number	Time (mins)	Area (sq km)	EleF
1	26	11	7.4	0
2	37	19	14.0	0
3	47	14	10.9	0
4	70	31	20.5	19
5	67	12	7.3	0
6	26			
7	49	10	10.7	0
8	64	7	7.7	0
9	71	19	19.3	0
10	59	19	15.9	5
11	81	15	10.2	0
12	70			
13	94	10	6.5	0
14	38	21	15.2	0

Sighting Totals:

				EleF
				24

Date of Survey : 10/07/14

Stratum Name : MWA high density

Stratum Locality : Zambezi Valley

Stratum Area : 273 sq km

n (sampled) : 5

n (searched) : 4

t : 2.776

Pilot : M. Henriksen

Recorder/Observer : G. Nyaguse

Block summary table :

	Number	Time (mins)	Area (sq km)	Donk
1	40	12	12.8	0
2	30	17	19.0	3
3	27	19	18.4	0
4	26	22	21.2	0
5	40			

Sighting Totals:

				Donk
				3

Aerial Survey of Elephants and other Large Herbivores in the Zambezi Valley (Zimbabwe): 2014

Date of Survey : 10-11 July 2014

Stratum Name : MWA low density

Stratum Locality : Zambezi Valley

Stratum Area : 379 sq km

n (sampled) : 6 n (searched) : 5

t : 2.571

Pilot : M. Henriksen

Recorder/Observer : G. Nyaguse

Block summary table :

	Number	Time (mins)	Area (sq km)
1	1	26	22.9
2	10	13	15.6
3	37	13	15.6
4	1		
5	44	7	7.0
6	45	19	13.9

Sighting Totals:

No large herbivores or elephant carcasses seen in the search blocks

Appendix 5. Comparison of observers

Introduction

During the first part of the transect survey, it was noticeable that the left observer saw more elephant groups inside his search strip than the right observer. Hence the left observer was thoroughly briefed as to what was expected of him and then provided with a camera and asked – from then on - to photograph all animals and carcasses that he saw between within his search strip. For the third period of the survey, the camera was switched to the right observer.

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

Methods

For each of the three survey periods and for each species/observation, 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

During the first period (when neither observer had a camera), the left observer saw more groups of elephant cows than the right observer (Table A5.1), confirming the suspicion raised during the survey flying. For other species, there were no differences between the observers in numbers of groups seen.

During the second phase (when only the left observer had a camera), there were no differences between the observers in the numbers of elephant groups seen (Table A5.2). But the left observer saw relatively few elephant carcasses. The right observer was the ZPWMA crocodile expert, which probably explains why he saw more crocodiles than the left observer

– probably he searched more thoroughly than the other observer for crocodiles when transects started or ended on the Zambezi River. Although the left observer saw fewer groups of impala than the right observer, he saw larger groups.

During the third period (when only the right observer had a camera), there were no differences between the observers in the numbers of elephant groups seen (Table A5.3). Nor were there differences of other species/observations, except for elephant carcasses category 4 – which the right observer saw more often.

Discussion

Most of the photographs taken by the two observers were never examined – the few that were studied were generally of disappointing quality, perhaps a reflection of the age of the Perspex that formed the windows of the plane and through which the photographs were taken. Hence the change in elephant sighting rate by the left observer, relative to the right, during the survey probably resulted from the observer's perception of how the photographs would be used, rather than how they were used.

However, the few photographs that were examined did reveal that the left observer could not reliably distinguish between elephant cow herds (herds that contained adult and juvenile elephants) and elephant bull groups (groups that comprised adult and sometimes subadult elephants). It was for this reason that Tables A5.1 – A5.3 included a line for 'elephant', which was the cow herds and bull groups combined.

An additional difference between the observers was shown by plots of the calibration data (Appendix 1). The left observer's calibration was poor – in the equation for a linear regression between the observer's strip width and aircraft height, the slope was small (0.09) and the intercept relatively large (139).

Conclusion

The analyses revealed that: the left observer saw significantly more elephants in his strip than did the (more experienced) right observer during the first phase of the transect survey; could not produce a satisfactory strip-width calibration; and could not reliably distinguish between elephant cow herds and bull groups. Hence, it was decided to produce the population estimates for elephants and other species in the transect strata using only the data from the right observer.

Reference

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

Table A5.1. Comparison of numbers and sizes of groups seen by the left and right observers during the period from August 21 until midday on August 23

This table covers the first period of the transect survey, specifically the first two and a half days of the survey. During this period, neither observer used a camera.

Expected numbers of groups were proportional to the observers' strip widths (Appendix 1). 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				
Baboon	0	5	3	2		2.0				
Buffalo	6	10	8	8	21.5	19.2	1.0	ns	29.5	ns
Carcass elephant 1	1	0	1	0	1.0					
Carcass elephant 2	2	0	1	1	1.0					
Carcass elephant 3	5	1	3	3	1.0	1.0				
Carcass elephant 4	17	24	21	20	1.0	1.0	1.6	ns		
Carcass elephant all	25	25	26	24	1.0	1.0	0.1	ns		
Carcass unidentified	3	2	3	2	1.0	1.0				
Crocodile	0	1	1	0		1.0				
Eland	4	1	3	2	3.5	1.0			0.5	ns
Elephant	111	78	97	92	4.2	3.9	4.2	0.042	3703.5	0.043
Elephant bull	35	42	39	38	1.9	2.1	0.8	ns	704.0	ns
Elephant cow	76	36	57	55	5.3	6.0	12.9	<0.001	1323.0	ns
Ground hornbill	2	0	1	1	3.5					
Hippopotamus	10	7	9	8	6.5	5.6	0.2	ns	28.5	ns
Impala	29	20	25	24	5.9	8.1	1.3	ns	225.5	ns
Kudu	5	4	5	4	1.4	2.3			5.0	ns
Warthog	1	2	2	1	3.0	4.5			1.0	ns
Waterbuck	1	0	1	0	4.0					
Zebra	6	5	6	5	4.3	2.2	0.0	ns	2.0	0.007

Table A5.2. Comparison of numbers and sizes of groups seen by the left and right observers during the period from midday on August 23 until August 28

During this second period of the transect survey, the left observer was equipped with a camera attached to his window so that, without interfering with his view of the search strip, he could trigger the camera to photograph those animals and carcasses that he saw inside the search strip. The right observer had no camera. See the note for Table A5.1 for details of the statistical tests.

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				
Baboon	0	3	2	1		4.3				
Buffalo	2	8	5	5	14.0	20.8	3.6	ns	7.5	ns
Carcass elephant 1	0	0	0	0						
Carcass elephant 2	1	0	1	0	1.0					
Carcass elephant 3	0	0	0	0						
Carcass elephant 4	0	10	5	5		1.0	10.0	0.002		
Carcass elephant all	1	10	6	5	1.0	1.0	9.2	0.002		
Carcass unidentified	1	0	1	0	1.0					
Cattle	30	32	32	30	10.0	6.9	0.3	ns	292.0	0.004
Crocodile	8	24	16	16	2.5	2.4	8.0	0.005	88.0	ns
Donkey	2	0	1	1	4.0					
Duiker	0	1	1	0		1.0				
Eland	4	3	4	3	3.0	5.0			2.5	ns
Elephant	79	66	74	71	2.8	3.8	0.7	ns	2429.0	ns
Elephant bull	52	37	46	43	2.4	2.0	1.6	ns	759.0	0.035
Elephant cow	27	29	29	27	3.7	6.2	0.3	ns	230.0	0.004
Ground hornbill	0	1	1	0		3.0				
Hippopotamus	30	33	32	31	5.7	8.0	0.3	ns	432.0	ns
Impala	15	31	24	22	12.1	4.4	7.1	0.008	87.0	<0.001
Kudu	6	5	6	5	3.0	1.4	0.0	ns	5.5	0.034
Sable	0	1	1	0		2.0				
Sheep/Goat	22	25	24	23	7.5	6.9	0.3	ns	243.0	ns
Warthog	1	5	3	3	5.0	2.8			1.0	ns
Waterbuck	5	11	8	8	3.6	4.6	2.3	ns	23.0	ns
Zebra	4	3	4	3	4.0	4.0			4.5	ns

Table A5.3. Comparison of numbers and sizes of groups seen by the left and right observers during the period August 29 to 31

During this third period of the transect survey, the right observer was equipped with a camera attached to his window so that, without interfering with his view of the search strip, he could trigger the camera to photograph those animals and carcasses that he saw inside the search strip. The left observer had no camera. See the note for Table A5.1 for details of the statistical tests.

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				
Baboon	4	0	2	2	5.3					
Buffalo	4	5	5	4	13.3	27.2			6.0	ns
Carcass elephant 1	0	0	0	0						
Carcass elephant 2	1	0	1	0	1.0					
Carcass elephant 3	0	0	0	0						
Carcass elephant 4	6	15	11	10	1.0	1.0	4.8	0.029	45.0	
Carcass elephant all	7	15	11	11	1.0	1.0	2.9	ns		
Carcass unidentified	1	0	1	0	1.0					
Cattle	52	36	45	43	8.3	11.3	2.2	ns	795.0	ns
Donkey	3	0	2	1	3.0					
Duiker	0	2	1	1		1.0				
Eland	1	0	1	0	9.0					
Elephant	48	46	48	46	4.5	4.6	0.0	ns	1003.5	ns
Elephant bull	23	18	21	20	2.5	1.8	0.4	ns	156.0	ns
Elephant cow	25	28	27	26	6.3	6.4	0.3	ns	294.5	ns
Impala	7	7	7	7	7.3	9.9	0.0	ns	21.0	ns
Kudu	2	3	3	2	6.5	2.0			2.5	ns
Sheep/Goat	33	31	33	31	8.1	10.2	0.0	ns	395.5	ns
Warthog	1	2	2	1	1.0	2.5			0.0	ns
Waterbuck	0	1	1	0		1.0				
Zebra	2	2	2	2	6.0	6.5			1.5	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 = 37.9 feet, SE = 0.8 feet, n = 2023 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.

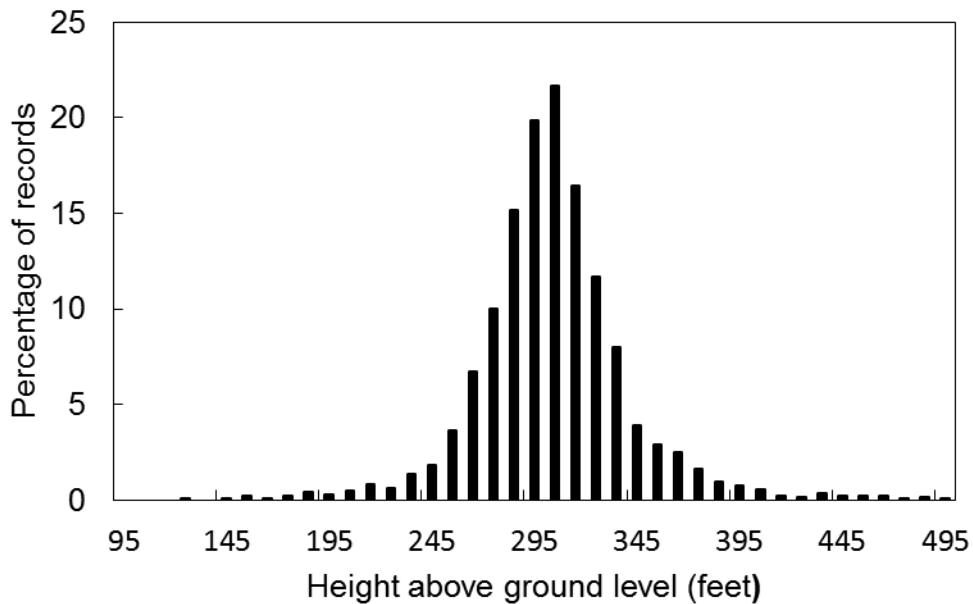


Fig. A6.1. Frequency distribution of flying height above ground level

Appendix 7. Ability of observers to estimate group sizes with acceptable accuracy

Prior to the survey, the observers were given a slide presentation that was intended to allow them to test and, by repeated use, to improve their ability to estimate group sizes. In the absence of a large number of aerial photographs of elephant herds, the pictures in the presentation were of circles scattered around the screen. The number of circles varied from 5 to 40 which represented the range of elephant herd sizes expected in the survey. Usually each slide contained a different number of circles (two numbers were used twice) and so there were 38 slides. There were two sizes of solid blue circles and the circles were presented on a pale blue background. The arrangement of the circles on the slide varied between slides, even when circle numbers were similar. The order in which the slides were presented was determined randomly. Each slide was displayed for three seconds before the correct number of circles was displayed.

Towards the end of the survey, the observers were shown a second presentation. This test presentation was generally similar to the training presentation, but not identical. The two sizes of circles were grey and the background was pale green. The number of circles varied from 8 to 40. Each slide was displayed to the observers for three seconds and then they were given time to write down their estimate of the number of circles on the slide. The slides were labelled with different letters of the alphabet. Towards the end of the test – and without warning – the observers were shown five slides that were low-level aerial photographs of elephant herds, with the number of elephants varying from 14 to 46. The final slide was an aerial photograph of a herd of 89 elephants. Herds as large as this were not expected to be encountered during the survey and hence were outside the range of group sizes included in the training presentation.

After the test, the observers were shown a different version of the test presentation that included the numbers of circles/elephants on each slide.

For each observer, the estimated number was regressed against the actual number (excluding the last data point). If an observer could estimate group size without error, a linear regression should have a slope (b) of 1 and an intercept (a) of 0. In practice, for the left observer, $b = 1.20$ (SE of $b = 0.072$) and $a = 0.26$ (SE of $a = 1.77$). For the right observer, $b = 1.04$ (SE of $b = 0.061$) and $a = 1.76$ (SE of $a = 1.60$).

Conclusion

The observers did not make wild guesses at group sizes for groups that they could not count, but were able to estimate group sizes with acceptable accuracy. However, the left observer tended to overestimate group sizes.

Ideally, future surveys should use photographs of herds of elephant (and other species) for training and testing. They should also use photographs of herds of >40 animals.

Table A7.1. Comparison of actual and estimated group sizes

Slide number	Actual number of dots (* elephants) on slide.	Estimated number of dots (* elephants)	
		Left observer	Right observer
1	23	28	22
2	31		30
3	33		40
4	21	29	18
5	27	35	28
6	34	45	40
7	13	18	16
8	35	35	43
9	29	32	28
10	12	16	15
11	19	23	22
12	9	11	11
13	38	52	42
14	17	22	22
15	20	23	18
16	10	11	12
17	18	22	18
18	40	42	40
19	14	15	16
20	32	42	32
21	24	25	30
22	15	15	18
23	39	48	48
24	16	17	18
25	11	11	13
26	26	32	22
27	8	9	8
28	25	21	26
29	22	28	30
30	28	34	32
31	36	42	42
32	30	38	38
33	37	46	46
34 *	19	35	22
35 *	46		42
36 *	14	16	22
37 *	20	27	26
38 *	89	58	62

Appendix 8. Calibration of laser rangefinder

On two occasions, readings from the laser rangefinder (no. MP6314024) were compared with those from the pilot's barometric altimeter. 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, the recorder would note the reading of the laser rangefinder. That the airstrips were 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 against the reading from the altimeter and the slope of the linear regression determined.

For pilot's altimeter

20 Aug: slope (b) = 1.086, SE of b = 0.064;

30 Aug: b = 1.080, SE of b = 0.139;

Table A8.1. Comparison of readings from laser rangefinder and barometric altimeter

Date	Pilot's barometric altimeter (ft)	Laser rangefinder (ft)
20 Aug 14	200	204
	300	320
	350	365
	400	
30 Aug 14	2500	401
	2460	272
	2300	144
	2310	190
	2400	275
	2500	384
	2300	154

Appendix 9. Great Elephant Census Review

On behalf of the Great Elephant Census (GEC), technical advisors were requested to review three aspects of the survey:

1. The execution of the survey against plans and according to GEC survey standards;
2. The completion of post-flight and post-census validations; and
3. The scientific interpretation of the findings.

With reference to aspects 1 and 2, the advisors concluded that:

- This report is an excellent example of internal validation and maintenance of standards: one observer's data were dropped from the estimate as the survey coordinator was able to conclude that his data were suspect (based on inspection of his data (left/right differences), calibration errors and use of cameras to provide a better check of data quality).
- The flight performance was good and no significant biases were likely from the conduct of the survey.

With reference to aspect 3, the advisors concluded that:

- This survey provides good evidence for a roughly 40 % decline in elephant number in the Zambezi Valley between 2001 and 2014, and there is no evidence that this was caused by any factor other than human-induced mortality.