



Aerial Survey of Elephants and other Large Herbivores in north-west Matabeleland, Zimbabwe: 2007

**K.M. Dunham, C.S. Mackie, O.C.
Musemburi, C. Zhuwau, T.G. Mtare,
R.D. Taylor & T. Chimuti**

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**WWF-SARPO
10 Lanark Road
Belgravia
Harare
Zimbabwe**

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The opinions expressed in this report are those of the authors and do not necessarily represent those of the WWF-SARPO, the Parks & Wild Life Management Authority, or the US Fish & Wildlife Service.

Summary

Elephants and other large herbivores, wild and domestic, were surveyed from the air in north-west Matabeleland in western Zimbabwe during October-November 2007. A fixed-wing aircraft was used to conduct a sample survey, flying transects over the area. The survey area totalled 24 570 km² and included Hwange National Park, Zambezi National Park, Kazuma Pan National Park, Matetsi Safari Area, Deka Safari Area, Ngamo and Sikumi Forest Areas and the Tsholotsho and Maitengwe communal lands along the south-east border of Hwange NP.

The principal objective of this survey was to provide a relatively precise and accurate estimate of the number of elephants in the survey area as a whole, using a technique that could be executed within a reasonable time and at a reasonable cost. 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, both repeatable and technically robust; were those most suitable for meeting the principal objective of the survey; and were similar to those used during the 2001 survey of elephants in this same region.

The sampling intensity in the 23 strata ranged from 3.2 to 15.4 %, with greater intensity in strata expected (on the basis of previous survey results) to contain greater densities of elephants. The overall sampling intensity was 8.1 %.

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) that 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 in the survey area were: elephant 39765 (upper and lower 95% confidence limits \pm 16.4 %); buffalo 24506 (\pm 121 %); zebra 4561 (\pm 31.6 %); sable 3368 (\pm 37.9 %); impala 4783 (\pm 54.0 %); giraffe 1471 (\pm 26.9 %); kudu 1283 (\pm 39.4 %); wildebeest 2318 (\pm 143 %); waterbuck 1390 (\pm 108 %); cattle 6523 (\pm 56.6 %); sheep and goats 890 (\pm 122 %); and donkeys 331 (\pm 115 %). During previous surveys, the domestic livestock were confined to the communal lands and forest areas, but during 2007 cattle were seen in Hwange NP and Matetsi SA.

The estimated total number of elephant carcasses (2563) represented 6.1 % of the estimated total number of live and dead elephants. This all-carcass 'ratio' compared with a ratio of 3.2 % recorded in the same area during 2001. The 1+2 carcass ratio (which reflects the mortality rate of elephants during the survey year) was 0.38 % during 2007, compared with 0.21 % during 2001. These increases suggest that there has been an increase in the mortality rate of elephants in the survey area during the last six years. The 1+2 carcass ratio was particularly high in the southern half of the Kazungula stratum and within a 40 km arc stretching from the north-west to the south-west of the PWMA's Main Camp offices. Many of the category 1 or 2 carcasses observed were near roads.

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Introduction

Large wild and domestic herbivores were censused in north-west Matabeleland, western Zimbabwe (Map 1), as part of a continuing study to monitor elephant numbers in the Parks & Wild Life Estate and communal lands of Zimbabwe. This region includes the largest block of Parks & Wild Life Estate in Zimbabwe, which has Hwange National Park as its centrepiece. The elephant population in this region is contiguous with the elephant population in northern Botswana.

The principal objective of this survey was:

- to provide a relatively precise and accurate estimate of the number of elephants *in the survey area as a whole* (i.e. in north-west Matabeleland), using a technique that could be executed within a reasonable time and at a reasonable cost.

Secondary objectives included:

- to determine the spatial distribution of elephants;
- to estimate the number and spatial distribution of elephant carcasses; and
- to estimate the numbers and spatial distributions of other large herbivores.

The methods used were:

- those most suitable for meeting the principal objective of the survey;
- repeatable;
- technically robust; and
- identical to those used during the surveys of elephants in this same region during 2001 and 2006 (Dunham 2002, Dunham *et al.* 2006).

The methods used were not necessarily those that would have been utilised if the principal objective of the survey had been, say, determining the spatial distribution of elephants (which was one of the secondary objectives).

Survey Area

The study area was similar to that covered in previous surveys of north-west Matabeleland (Dunham 2002) and included Parks & Wild Life Land (Hwange National Park, Zambezi National Park, Kazuma Pan National Park, Matetsi Safari Area and Deka Safari Area), Forest Areas (Sikumi Forest Area, Ngamo Forest Area and Kazuma Forest Area), communal land (parts of Tsholotsho and Maitengwe communal lands) adjacent to the eastern boundary of Hwange National Park, and small, private estates adjacent to Sikumi Forest Area (Map 2). To the west of the survey area is Botswana, and elephants are free to cross the international border at will. The northern border of the survey area is the Zambezi River, which forms the international border with Zambia, and elephants are also free to cross this boundary.

The study area covered 24 570 km² and was divided into 23 strata (Table 1 and Map 3). The strata boundaries were the same as those used during the 2001 and 2006 surveys, except for the single stratum North Tsholotsho. Although the survey design required the entire North Tsholotsho stratum to be sampled as during 2006, in practice only the northern part of this stratum was sampled during 2007 (see below for more details). In order to minimise confusion, the stratum sampled during 2007 is called here Far North Tsholotsho. Its area was 474 km² (Table 1), which is approximately half the area of the North Tsholotsho stratum. Far North Tsholotsho covers the northern half of North Tsholotsho. This small change in the survey area makes little practical difference to the estimate of the number of elephants in north-west Matabeleland, because just two elephants were seen in the search strips of North Tsholotsho during the 2001 survey (Dunham 2002) and none were seen during the 2006 survey (Dunham *et al.* 2006).

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. 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 3 and Table 1 for transect orientations). In order to maximise the precision of the estimate of the total number of elephants, the sampling intensity varied between strata. Hence, the distance between adjacent transects varied between strata, according to the planned sampling intensity in each stratum. Overall sampling intensity was planned to be 7.2 %, with a transect width (i.e. combined width of the two search strips) of 300 m. The planned sampling intensity in each stratum was determined by using the mean of the elephant densities in each stratum during 1998, 1999 and 2001 (Dunham 2000, 2002, Gibson 1999) as the predicted elephant densities in equation 1 of Gibson (1989). As a consequence, those strata expected to contain high densities of elephants were sampled more intensively than strata expected to contain few elephants. In practice, the transect spacing varied from 2.2 km in strata expected to contain numerous elephants, to 10.0 km in strata expected to contain few or no elephants (Table 1).

The survey was designed using 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 prior to flying each stratum.

The design used during 2007 was originally prepared for the 2006 survey, but technical problems with the survey plane prevented completion of the 2006 survey. Hence, the same survey plan was used during 2007 as during 2006. Consequently, for strata surveyed during both 2006 and 2007, the transects flown were identical in the two years.

Flight Procedures

All strata were surveyed during the period 27 October to 10 November 2007 (Table 1).

The aircraft used was a Cessna 206, which was fitted with a radar altimeter. During surveys, the aircraft was flown at approximately 160 km per hour at about 300 feet above ground level. Waypoints denoting the start and end points of transects were entered into a Garmin GPSMap276C GPS receiver and navigation along the transects was undertaken by the pilot, with reference to this GPS receiver.

The aircraft crew included a pilot (Charles Mackie), a recorder (Ongai Musemburi) who sat next to the pilot, and two observers who sat behind the pilot and recorder. All four crew members could talk to one another through an intercom system. The two observers were Colum Zhuwau and Godfrey Mtare. Prior to this survey, Mr Zhuwau had experience of observing during aerial surveys, having served as an observer for the Sebungwe and north-west Matabeleland surveys during 2006 and for the Gonarezhou survey during 2007 (Dunham *et al.* 2006a,b, 2007), while Mr Mtare had no previous experience as an observer.

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 using the Garmin GPSMap276C GPS receiver. During the surveys, the actual height of the plane above ground level (agl) was recorded by the recorder, from the radar altimeter, 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.

Observations

Although this survey was designed especially to count elephants, the observers were instructed 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. Groups of elephant bulls were differentiated from elephant cow herds (i.e. herds containing calves), although the latter may have included some bulls. Ground hornbills are large and conspicuous birds and any seen were counted. Any ostriches or poachers' camps seen were also counted.

The observers were instructed to note any carcasses seen. Any carcass that could not be identified to species was recorded as an 'unidentified carcass'. 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. (Likely to have died within the past month).
2	Recent Rot patch and skin still present. Skeleton not scattered. (Likely to have died within the past year).
3	Old Clean bones; skin usually absent; vegetation regrown in rot patch. (Likely to have died more than 1 year ago).
4	Very Old Bones scattered and turning grey. (Likely to have died within the last 10 years).

These carcass categories differ from those used during previous surveys of this region, when only three categories were used (Dunham 2002). The new categories are those used by Douglas-Hamilton & Hillman (1981) and now recommended by MIKE for elephant surveys (Craig undated). 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.

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 whether 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 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 radar altimeter. For each flight passing over the calibration numbers, the combined strip width (in meters) was adjusted to 300 feet above ground level as follows:

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

The combined strip widths, after adjustment to 300 feet above ground level, were then averaged to give the nominal (calibrated) combined strip width at 300 feet. This was 328 m (Appendix 1).

Data Analysis

Far North Tsholotsho stratum

The survey design required the entire North Tsholotsho stratum to be sampled, as during 2006. This stratum, in the north of the Tsholotsho communal land and along the eastern edge of the survey area, was flown without the use of a GPS receiver to aid navigation, because the GPS receiver malfunctioned. During data analysis, it became clear from the transect flying times for this stratum that the transects actually flown were generally much shorter than the intended transects. It appeared that the road used as the southern boundary of the stratum whilst flying was not the correct road. The transect flying times and the mean ground velocity when flying transects in another stratum (Dzivanini) were used to estimate the lengths of the transects flown in North Tsholotsho and thereby determine which road was used as the southern border of the stratum. This road was taken as the southern border of a new stratum, now called Far North Tsholotsho. The area of this new stratum and the lengths of the transects flown were determined using the spatial data software CARTALINX (Hagan *et al.* 1998).

This change in the survey area makes little practical difference to the estimate of the number of elephants in north-west Matabeleland, because few elephants were seen in the North Tsholotsho during the 2001 and 2006 surveys. However, the change will have greater impact on the estimated numbers of domestic livestock, because most of those in the survey area are in the communal lands.

Transect surveys

Population estimates and 95 % confidence limits for individual strata were calculated with WWF-SARPO's custom software (AIRSURVW, version dated 22/05/97). This software uses Jolly's (1969) method 2 for unequal-sized sample units. Given the mean combined strip width when the plane was flying at 300 feet (i.e. the calibrated strip width), and the mean flying height for each transect, the software determines the actual combined strip width for each transect. The actual combined strip width is 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 is calculated as the product of the actual combined strip width and the transect length. Transect lengths were provided by the survey design software (Appendix 3).

Transects near the boundary of a stratum were sometimes broken into two or more sections, with land outside the stratum between the sections. For the purposes of analysis, data for all sections of the same transect were combined and entered into the software as one transect. 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 WWF-SARPO custom software AIRSURVW calculates the 95 % confidence *interval* as the difference between the mean population estimate and the upper (or lower) 95 % confidence *limit*. The lower 95 % confidence limit is displayed as zero if the calculated value is negative.

Entire survey area

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 the relevant land unit. The upper and lower 95% confidence limits for such a population estimate 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:

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

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 carcass "ratio" *sensu* Douglas-Hamilton & Burrill (1991) - although it is a 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 carcass ratios are based on all elephant carcasses,

regardless of age category, the ratios are unaffected by the age categories used during a survey, and hence are unaffected by the use of new age categories during 2006 and 2007. The elephant carcass ratios and densities given here are directly comparable with the ratios and densities from previous surveys of this region.

When interpreting the results of this survey, it is reasonable to assume that all category 1 or 2 carcasses represent elephants that died during 2007. Hence, the 1+2 carcass ratio provides an index of elephant mortality (both natural and anthropogenic) during 2007 and it was calculated as the estimated number of elephant carcasses in age categories 1 or 2 as a percentage of the sum of the estimated number of live elephants and the estimated number of carcasses in age categories 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 within that stratum, divided by the total area of those same transects.

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. No corrections have been applied to any of the estimates to compensate for any undercounting or missed animals.

Results

Search Effort

Overall, search effort averaged 1.02 minutes km⁻² (Table 1).

Animal Numbers

The estimated numbers of elephants, elephant bulls in bull groups, elephants in cow herds, elephant carcasses (age categories 1, 2, 3 and 4), unidentified carcasses, buffalo, impala, sable, zebra, giraffe, kudu, warthog, wildebeest, waterbuck, eland, roan, cattle, sheep and goats, donkey, ostrich and ground hornbill are given in Tables 2 to 25 respectively. Estimates are given for each stratum and for the entire survey area. Separate estimates are provided for the Matetsi Complex, Hwange National Park, the Ngamo and Sikumi Forest Areas, and the surveyed portions of the communal lands of Tsholotsho and Maitengwe.

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

- the name of the **stratum** (or of a **land unit** comprised of several strata);
- the **estimate** of the number of animals of that species (or of carcasses, camps, etc.) in that stratum or land unit, in other words the population estimate;
- the number of individuals of that species seen (**No. seen**) *inside the search strips* during the survey of that stratum or land unit;
- the **variance** of the estimated number of animals in that stratum or land unit;
- the 95 % confidence interval of the population estimate for that species in the stratum or land unit, as a percentage of the population estimate for that stratum or land unit (**% CI**);

- the lower 95 % confidence limit of the population estimate (**Lower CL**); and
- the upper 95 % confidence limit of the population estimate (**Upper CL**).

There may appear to be small arithmetic 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.

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 the bottom of Table 2, one can say that there were between 33229 and 46300 elephants in north-west Matabeleland, with 39765 being the best estimate of the number of elephants in the area. For practical purposes, one might say that there were between 33000 and 46000 elephants in the survey area during the late dry season of 2007, with 40000 being the best estimate of the number of elephants there.

Small numbers of duiker, hippo, black rhino, white rhino, steinbuck, jackal, crocodile, lion and bushbuck were seen during the survey, but no attempt has been made to estimate the numbers of these species. No gemsbok or tsessebe were recorded during the survey.

Animal Distributions

The spatial distribution of the principal wild herbivores is shown in Maps 4-6 and 9-19, with each stratum shaded to represent the average density of the given species in that stratum. The spatial distribution of elephant carcasses is shown in Map 7 (category 1 and 2 carcasses) and Map 8 (all-carcass ratios and category 3 and 4 carcasses).

Encroachment on the Parks & Wildlife Estate

The spatial distribution of cattle in the Parks and Wildlife Estate is shown in Map 20. The estimated number of poachers’ camps is given in Table 26 and the spatial distribution of these camps is shown in Map 21.

Comparison of Observers

A comparison of the numbers of elephants seen in the search strips by the observers (Appendix 5) did not suggest that there were any major differences in the efficiency of the two observers at counting elephants.

Discussion

Caveat

This survey took place later during the year than was originally planned because delays in executing an earlier survey in south-east Zimbabwe had a knock-on effect and delayed the north-west Matabeleland survey. Consequently, this survey was not completed before the end of the dry season. Some rain had fallen in the study area before the survey was completed and some rain showers occurred during the survey period. Hence, one cannot be certain that significant movements of elephants between strata did not occur during the survey.

The problem of rain during the survey period has occurred before, for example during the 1993 survey of north-west Matabeleland (Bowler 1995), and cannot always be avoided

simply by conducting the survey earlier during the dry season (the 1993 survey was flown during late September and early October, a month earlier than the 2007 survey).

Elephants

There were estimated to be 39765 elephants (lower and upper 95 % confidence limits 33229 and 46300) in north-west Matabeleland study area during 2007. This is less than the estimated number of elephants in the same area during 2001 (49310, with confidence limits 43222 and 55398 (Dunham 2002)). The overlap between the confidence intervals of the two estimates is relatively small. However, given the fact that one cannot be certain that significant movements did not occur during the survey as a consequence of rain, also one cannot be certain that there has been a genuine decline in elephant number. It is probably relevant to note that the 2006 survey – which covered the southern two-thirds of the survey area – found no evidence of any decline in the number of elephants here (Dunham *et al.* 2006).

Given the uncertainty as to whether the number of elephants in north-west Matabeleland has declined, or whether there only appears to have been a decline because the survey was compromised by rain during the survey period, the best course of action would be a repeat survey in the near future. The problem of interpreting the results of this year's survey does emphasise the value of conducting regular surveys at relatively short intervals, for example 1-2 years, rather than at lengthy intervals (e.g. 5+ years).

Elephant Carcasses

The estimated total number of elephant carcasses of all age categories (2563) represented 6.1 % of the estimated total number of live and dead elephants. This all-carcass 'ratio' (which reflects the mortality rate of elephants during the several years preceding the survey) is nearly double the ratio of 3.2 % recorded in the same area during 2001 (Dunham 2002). The 2006 survey that covered the southern two-thirds of the survey area showed a similar increase in the all-carcass ratio (Dunham *et al.* 2006). The 1+2 carcass ratio (which reflects the mortality rate of elephants during the survey year) was 0.38 % during 2007, compared with 0.21 % during 2001. The number of unidentified carcasses in the survey area during 2007 (1543) was similar to that recorded during 2001 (1492). These observations suggest that there has been an increase in the mortality rate of elephants in the survey area during the last six years. However, the observed increase in the carcass ratios would not be sufficient to account for the apparent decline in the number of live elephants.

The all-carcass ratio was high in the strata of the Matetsi Complex, compared with the strata within Hwange NP (Table 8). Within Hwange NP, the all-carcass ratio was relatively high (> 9 %) in the Robins, Mtoa, Main Camp and Ngamo strata.

The carcasses of elephants that died during 2007 (i.e. category 1 or 2 carcasses) were not distributed evenly across the survey area, but occurred in four groups, two major and two minor (Map 7). One major group was in the southern half of the Kazungula stratum, where the 1+2 carcass ratio was particularly high at 24 % for the stratum as a whole (Table 6). The 1+2 carcass ratio was also relatively high (> 1.3 %) in the Main Camp and Mtoa strata, reflecting the presence of the second major group of carcasses within a 40 km arc stretching from the north-west to the south-west of the PWMA's Main Camp offices. Many of the category 1 or 2 carcasses observed were near roads: nine of 19 carcasses observed are close to strata boundaries, which are usually roads (the survey area having been stratified during the days before GPS receivers were available to assist navigation). The obvious conclusion to be drawn from an association between elephant carcasses and roads is that few of these carcasses are of elephants that died from natural causes.

Encroachment on the Parks & Wildlife Estate

Cattle were recorded in both Hwange NP and Matetsi Safari Area (Map 20 and Table 21). Although the numbers of cattle were small, it appears that this is the first survey to record the encroachment of domestic livestock on the Parks and Wildlife Estate in north-west Matabeleland.

Responsibilities

In line with recent recommendations on authorship in ecology (Weltzin *et al.* 2006), the survey responsibilities of the authors are summarised below:

- KMD was solely responsible for designing the survey, data analysis, mapping and writing this report;
- CSM piloted the aircraft, coordinated aviation aspects of the survey and was co-responsible for survey logistics;
- OM was the recorder (with responsibility for recording all sightings, transect, stratum and flight times, using the GPS receiver to enter transect start and end points, recording sighting locations and downloading waypoint and track log files, and assisting the pilot with navigation);
- CZ and GM were the observers (who brought sharp eyes, good humour and team spirit to one of the most-important but least-appreciated roles in any aerial survey);
- RDT drafted the project proposal to United States Fish & Wildlife Service and was responsible for overall co-ordination of the survey programme; and
- TC co-ordinated the role of the PWMA in the survey.

Acknowledgements

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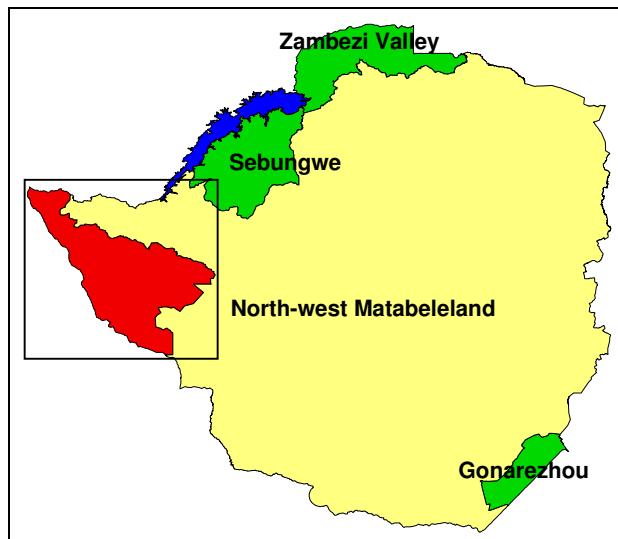
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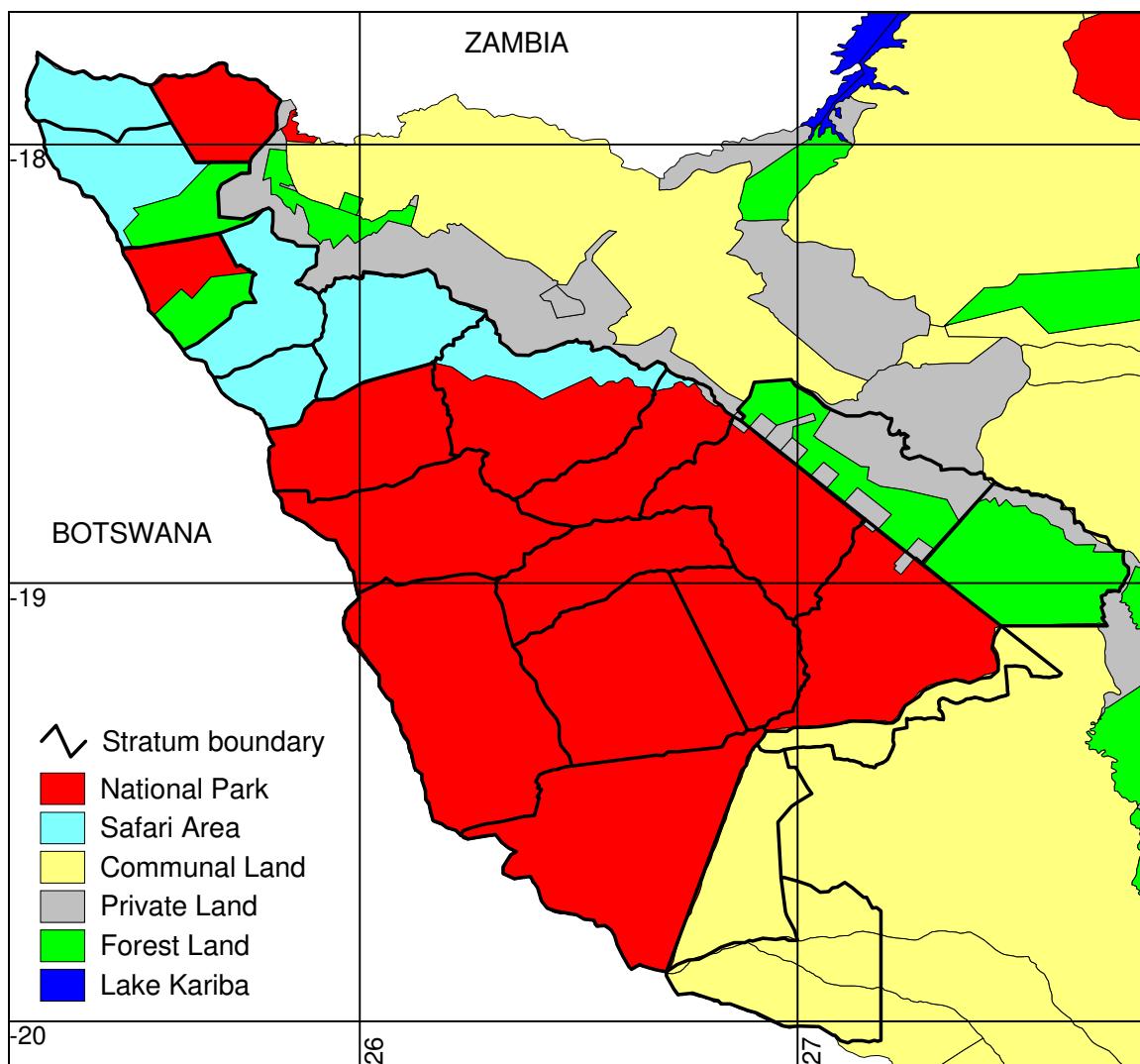
Table 1. Sampling statistics for 2007 aerial survey of large herbivores in north-west Matabeleland

Stratum name	Stratum area (km ²)	Transect spacing (km)	Transect orientation (°)	Number of transects [= n]	Percent of stratum sampled	Time and date sampled	Flying time (hours) ^a			Search effort (minutes km ⁻²)
							Transect	Stratum	Total	
Zambezi NP	543	4.2	0	7	7.70	pm 27 Oct	0.73	0.95	2.22	1.03
Kazungula	446	2.3	0	15	14.49	am 27 Oct	1.11	1.70	2.92	1.03
Panda Masuie	963	4.7	0	11	7.02	am 28 Oct	1.20	1.72	2.78	1.07
Kazuma	561	4.7	0	7	7.33	am 28 Oct	0.62	0.90	2.42	0.91
Matetsi	703	6.9	-50 (130)	6	5.19	am 29 Oct	0.63	0.92	1.97	1.03
Rosslyn	344	4.6	90	5	7.09	am 29 Oct	0.42	0.65	1.63	1.04
Zanguja	839	5.1	29	9	6.51	pm 29 Oct	0.91	1.28	2.43	1.00
Robins	1029	2.6	90	14	12.84	am 30 Oct	2.30	2.82	4.02	1.05
Dandari	1290	2.9	0	25	11.45	am 5 Nov	2.47	3.18	4.33	1.00
Shakwanki	2143	6.3	90	11	5.27	am 6 Nov	1.89	2.50	3.68	1.01
Dzivanini	2098	4.3	90	14	7.66	am 8 Nov	2.63	3.28	4.50	0.98
Sinamatella	1522	2.9	0	20	11.73	am pm 31 Oct	3.05	3.72	5.12	1.02
Mtoa	826	3.0	0	18	10.86	pm 30 Oct	1.58	2.12	2.62	1.06
Main Camp	1261	2.2	41	23	15.40	pm 4 & 5 Nov	3.13	3.73	4.63	0.97
Shapi	923	2.8	0	21	11.49	am 1 Nov	1.82	2.55	3.12	1.03
Central B	1723	9.5	-26 (154)	4	3.23	pm 7 Nov	0.91	1.10	1.85	0.98
Central A	775	3.9	66	12	8.55	am 9 Nov	1.17	1.55	1.93	1.06
Ngamo	1629	2.5	-52 (128)	22	13.13	am 7 Nov	3.50	4.08	4.65	0.98
Tsholotsho East	910	6.9	90	9	4.95	pm 9 Nov	0.83	1.30	2.38	1.10
Maitengwe	1224	9.5	0	6	3.52	am 10 Nov	0.72	1.10	2.42	1.00
Tsholotsho Far North	474	10.0	0	8	3.44	am 9 Nov	0.25	0.57	1.20	- ^c
Ngamo Forest	1171	9.0	41	5	3.53	pm 8 Nov	0.70	0.97	1.75	1.02
Sikumi Forest	1173	7.1	41	9	5.01	pm 6 Nov	1.00	1.55	2.00	1.02
Total / mean	24570 km²			Overall	8.11^b %		33.59	44.23	66.57	1.02

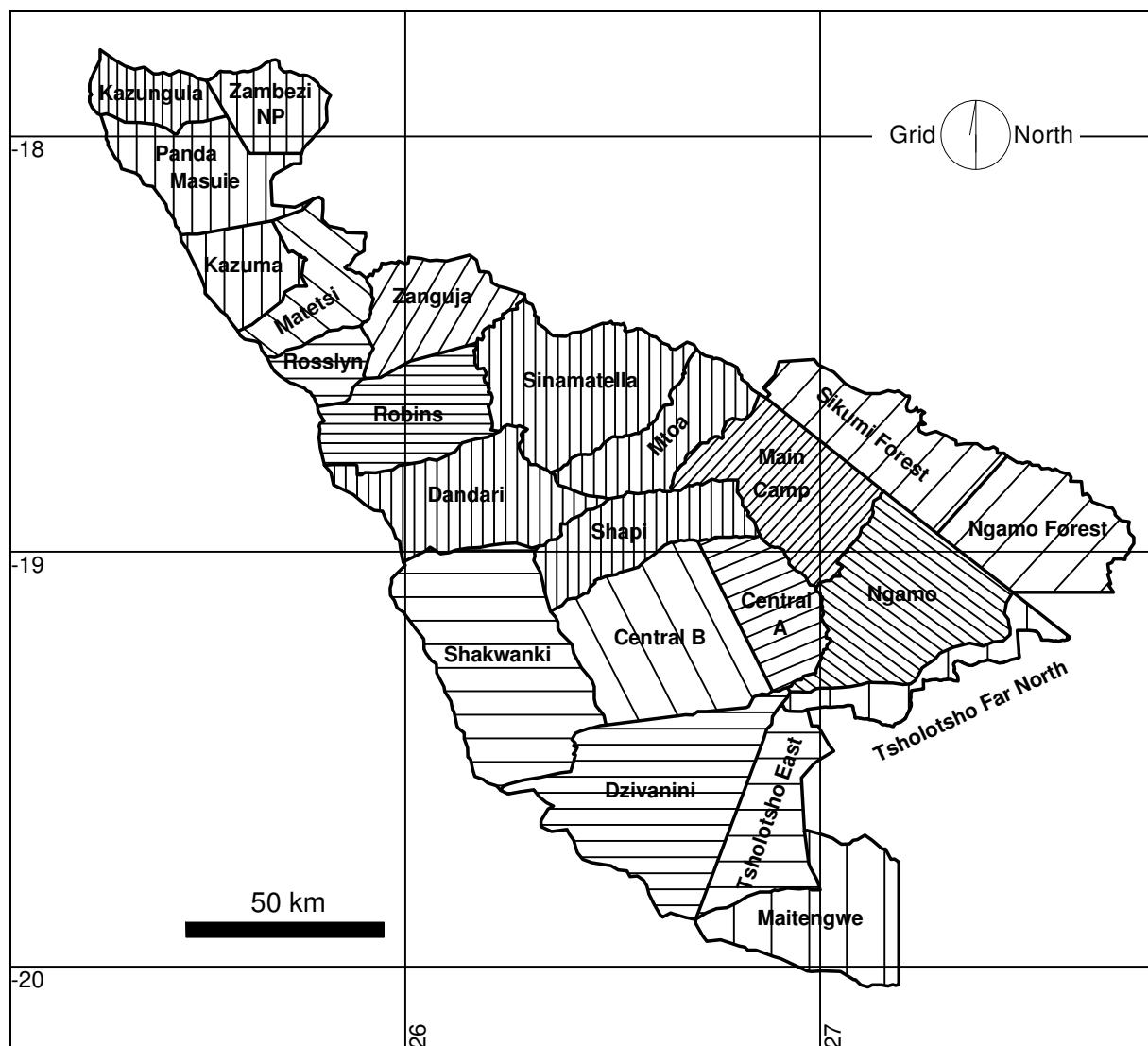
^a Transect time is the time spent searching the transects; stratum time is the transect time, plus the time spent travelling between transects in the same stratum; and total time is the stratum time, plus the time spent travelling between the stratum and the airstrip. ^b Weighted mean, with stratum area as a proportion of the total area as weight. ^c times used to estimate transect lengths.



Map 1. The four regions of Zimbabwe where elephant populations have been surveyed regularly. The box highlights the north-west Matabeleland survey region, which is shown in detail in Map 2.



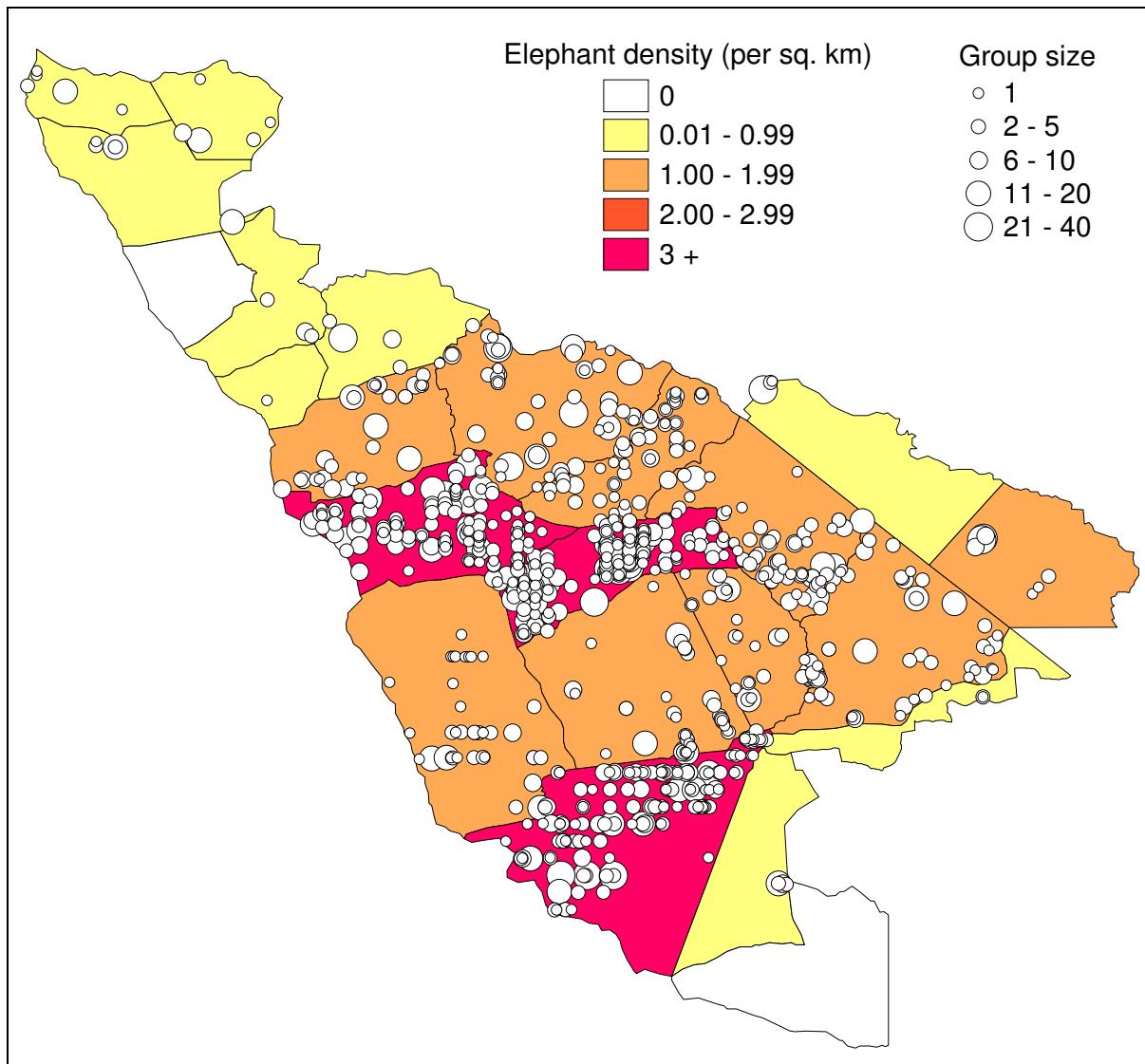
Map 2. Land use in and adjacent to the north-west Matabeleland survey area.



Map 3. Strata and transects used during the 2007 aerial survey of north-west Matabeleland.
Bold lines indicate strata boundaries, thin parallel lines indicate transects and labels give strata names.

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

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	348	27	52133	160.8	0	906	0.64
Kazungula	152	22	10338	143.6	0	370	0.34
Panda Masuie	456	32	87890	145.0	0	1116	0.47
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	231	12	52154	254.2	0	818	0.33
Rosslyn	14	1	127	221.5	0	45	0.04
Zanguja	629	41	86093	110.3	0	1323	0.75
Subtotals	1829	135	288735	60.0	732	2927	0.42
Hwange NP							
Robins	1176	151	101376	58.5	489	1864	1.14
Dandari	4893	560	577755	32.1	3324	6461	3.79
Shakwanki	2353	124	602706	73.5	623	4083	1.10
Dzivanini	7950	609	1693601	35.4	5139	10761	3.79
Sinamatella	2702	317	355380	46.2	1454	3950	1.78
Mtoa	1326	144	65298	40.7	787	1865	1.61
Main Camp	1890	291	151475	42.7	1083	2697	1.50
Shapi	5812	668	893232	33.9	3840	7783	6.30
Central B	3187	103	1023253	101.0	0	6406	1.85
Central A	1334	114	230012	79.1	278	2390	1.72
Ngamo	1699	223	167429	50.1	848	2550	1.04
Subtotals	34322	3304	5861517	14.2	29459	39185	2.26
Communal Areas							
Tsholotsho East	687	34	373029	205.0	0	2095	0.76
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	146	5	16404	208.1	0	448	0.31
Subtotals	833	39	389433	172.9	0	2272	0.32
Forest Areas							
Ngamo Forest	2182	77	3335298	232.3	0	7252	1.86
Sikumi Forest	599	30	366759	233.2	0	1995	0.51
Subtotals	2781	107	3702057	192.1	0	8123	1.19
Totals	39765	3585	10241742	16.4	33229	46300	1.62



Map 4. Distribution of elephant cows in NW Matabeleland during October-November 2007

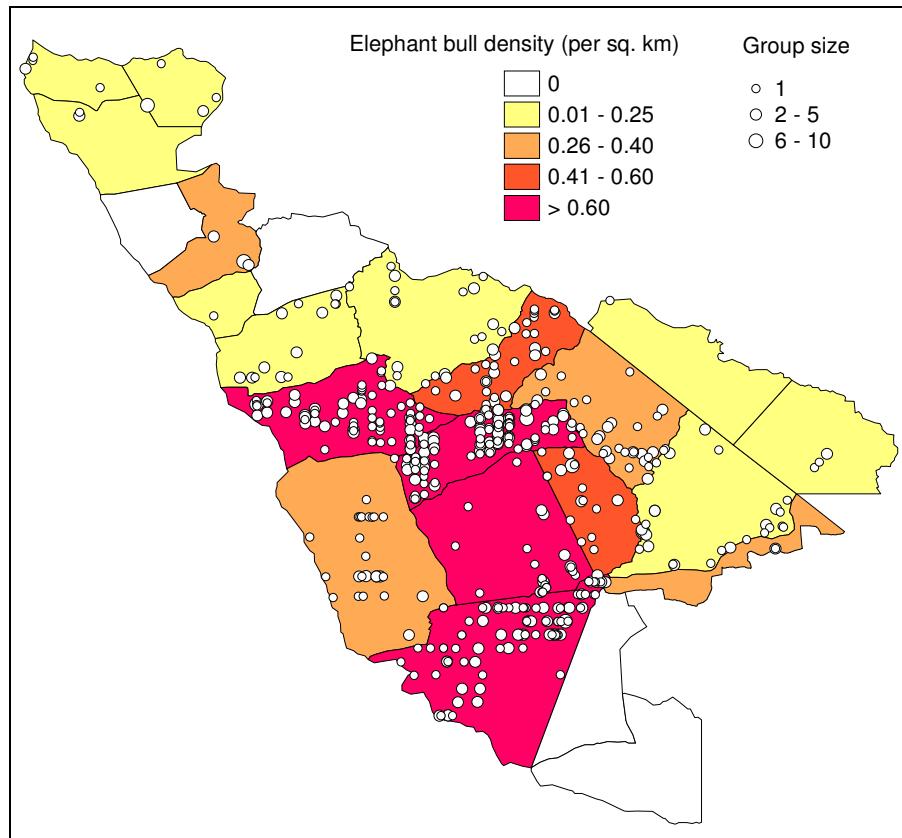
Colouring indicates the mean density of elephants within each stratum. Dots indicate the locations of elephants seen *within the search strips*, together with an indication of the size of each group. Small dots overlaying large dots indicate two or more groups of elephants in close proximity. Variation in dot density between strata is a reflection of differences between strata in *both* the density of elephant groups and the sampling intensity (which is given in Table 1).

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

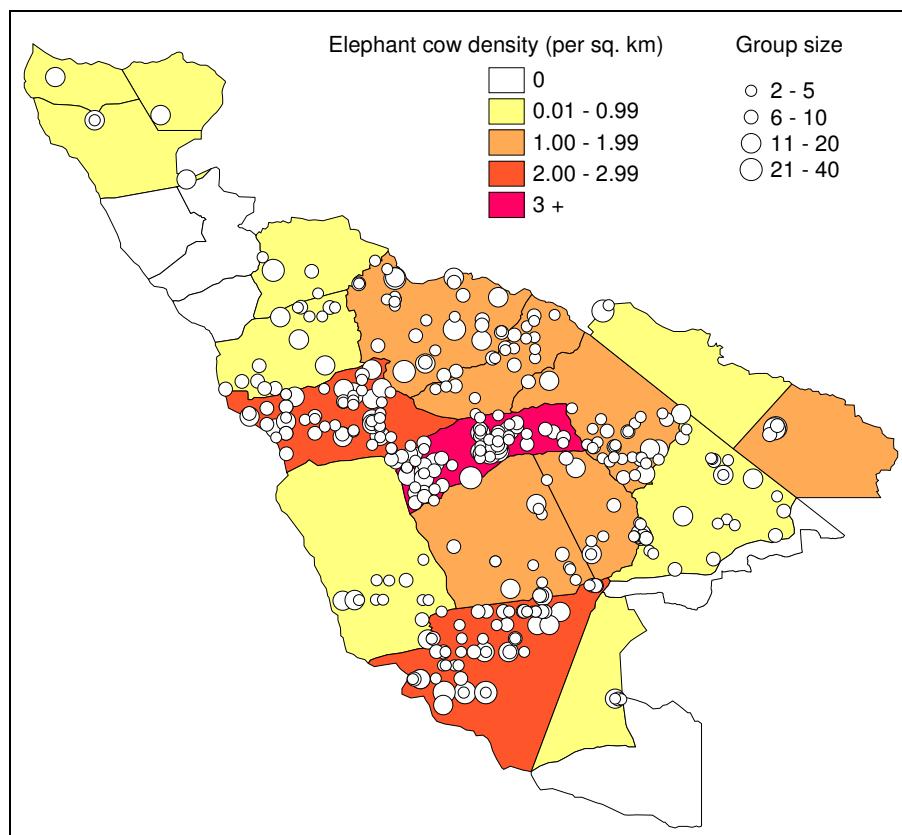
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	129	10	6126	148.8	0	320	0.24
Kazungula	48	7	917	134.4	0	113	0.11
Panda Masuie	43	3	1880	226.2	0	139	0.04
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	231	12	52154	254.2	0	818	0.33
Rosslyn	14	1	127	221.5	0	45	0.04
Zanguja	0	0	0	0.0	0	0	0.00
Subtotals	465	33	61204	130.2	0	1070	0.11
Hwange NP							
Robins	203	26	4671	72.9	55	350	0.20
Dandari	1066	122	38470	38.0	661	1471	0.83
Shakwanki	702	37	72787	85.6	101	1303	0.33
Dzivanini	2141	164	222050	47.5	1123	3159	1.02
Sinamatella	256	30	5967	63.2	94	417	0.17
Mtoa	479	52	15487	54.8	216	741	0.58
Main Camp	390	60	6302	42.2	225	554	0.31
Shapi	1479	170	78899	39.6	893	2065	1.60
Central B	1052	34	244178	149.5	0	2624	0.61
Central A	398	34	20446	79.1	83	713	0.51
Ngamo	343	45	9315	58.6	142	544	0.21
Subtotals	8507	774	718571	20.8	6739	10276	0.56
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	146	5	16404	208.1	0	448	0.31
Subtotals	146	5	16404	208.1	0	448	0.06
Forest Areas							
Ngamo Forest	113	4	9401	237.4	0	383	0.10
Sikumi Forest	20	1	436	241.1	0	68	0.02
Subtotals	133	5	9837	206.5	0	409	0.06
Totals	9251	817	806016	20.0	7402	11100	0.38

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

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	219	17	46006	239.9	0	744	0.40
Kazungula	104	15	9422	201.1	0	312	0.23
Panda Masuie	413	29	86011	158.3	0	1066	0.43
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	0	0	0	0.0	0	0	0.00
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	629	41	86093	110.3	0	1323	0.75
Subtotals	1365	102	227531	72.0	382	2347	0.31
Hwange NP							
Robins	974	125	96706	69.0	302	1646	0.95
Dandari	3827	438	539285	39.6	2311	5342	2.97
Shakwanki	1651	87	529919	98.2	29	3273	0.77
Dzivanini	5809	445	1471551	45.1	3189	8430	2.77
Sinamatella	2446	287	349413	50.6	1209	3683	1.61
Mtoa	847	92	49812	55.6	376	1318	1.03
Main Camp	1500	231	145173	52.7	710	2291	1.19
Shapi	4333	498	814333	43.4	2450	6215	4.69
Central B	2135	69	779075	131.5	0	4944	1.24
Central A	936	80	209565	107.6	0	1944	1.21
Ngamo	1356	178	158114	61.0	529	2183	0.83
Subtotals	25814	2530	5142946	17.6	21275	30354	1.70
Communal Areas							
Tsholotsho East	687	34	373029	205.0	0	2095	0.76
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	687	34	373029	205.0	0	2095	0.26
Forest Areas							
Ngamo Forest	2069	73	3325897	244.7	0	7131	1.77
Sikumi Forest	579	29	366323	241.1	0	1975	0.49
Subtotals	2648	102	3692220	201.5	0	7983	1.13
Totals	30514	2768	9435726	20.7	24211	36816	1.24



Map 5. Distribution of elephant bulls in NW Matabeleland during October-November 2007



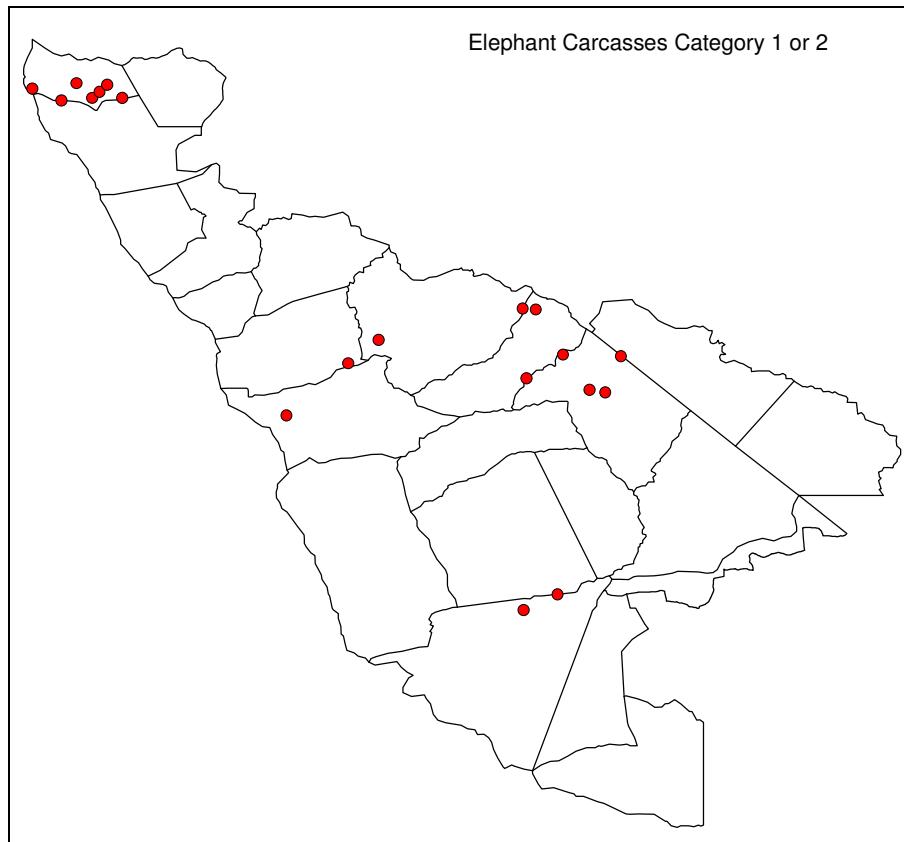
Map 6. Distribution of elephant cows in NW Matabeleland during October-November 2007

Table 5. Population estimates and statistics for Elephant Carcasses 1 in north-west Matabeleland

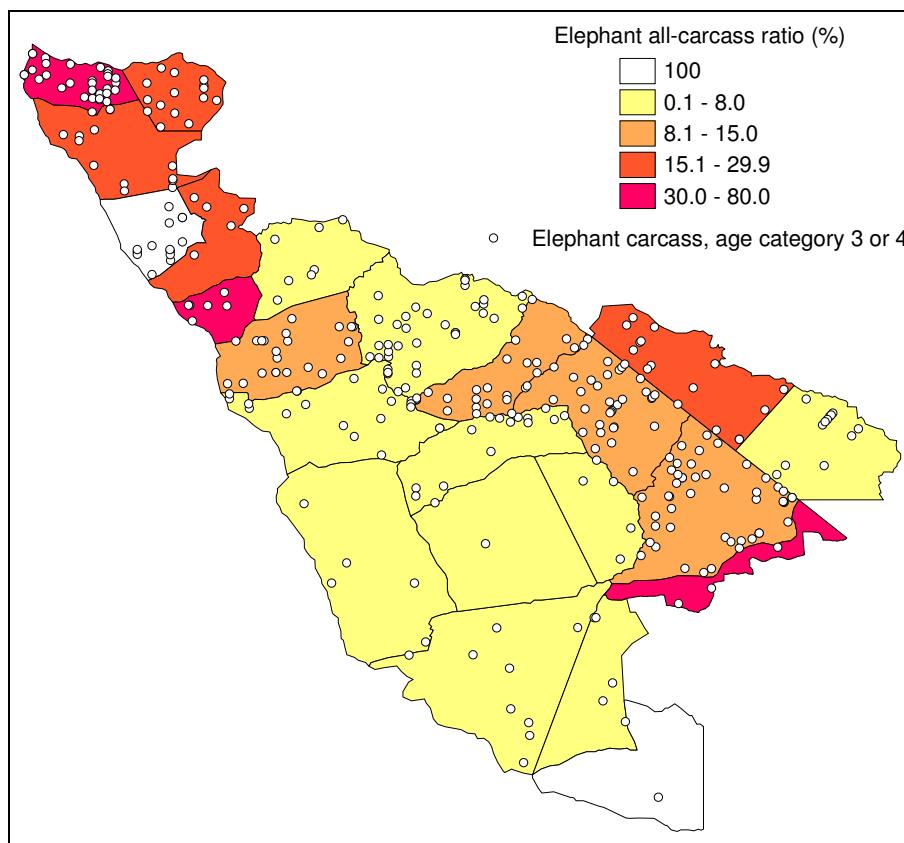
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.000
Kazungula	0	0	0	0.0	0	0	0.000
Panda Masuie	0	0	0	0.0	0	0	0.000
Kazuma	0	0	0	0.0	0	0	0.000
Matetsi	0	0	0	0.0	0	0	0.000
Rosslyn	0	0	0	0.0	0	0	0.000
Zanguja	0	0	0	0.0	0	0	0.000
Subtotals	0	0	0	0.0	0	0	0.000
Hwange NP							
Robins	0	0	0	0.0	0	0	0.000
Dandari	9	1	65	191.0	0	25	0.007
Shakwanki	0	0	0	0.0	0	0	0.000
Dzivanini	0	0	0	0.0	0	0	0.000
Sinamatella	0	0	0	0.0	0	0	0.000
Mtoa	9	1	69	190.1	0	27	0.011
Main Camp	6	1	37	194.1	0	19	0.005
Shapi	0	0	0	0.0	0	0	0.000
Central B	0	0	0	0.0	0	0	0.000
Central A	0	0	0	0.0	0	0	0.000
Ngamo	0	0	0	0.0	0	0	0.000
Subtotals	24	3	171	107.2	0	51	0.002
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.000
Maitengwe	0	0	0	0.0	0	0	0.000
Tsholotsho Far North	0	0	0	0.0	0	0	0.000
Subtotals	0	0	0	0.0	0	0	0.000
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.000
Sikumi Forest	0	0	0	0.0	0	0	0.000
Subtotals	0	0	0	0.0	0	0	0.000
Totals	24	3	171	107.2	0	51	0.001

Table 6. Population estimates and statistics for Elephant Carcasses 2 in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)	1+2 Carcass Ratio (%)
Matetsi Complex								
Zambezi NP	0	0	0	0.0	0	0	0.000	0.00
Kazungula	48	7	164	56.8	21	76	0.108	24.00
Panda Masuie	0	0	0	0.0	0	0	0.000	0.00
Kazuma	0	0	0	0.0	0	0	0.000	-
Matetsi	0	0	0	0.0	0	0	0.000	0.00
Rosslyn	0	0	0	0.0	0	0	0.000	0.00
Zanguja	0	0	0	0.0	0	0	0.000	0.00
Subtotals	48	7	164	56.8	21	76	0.011	2.56
Hwange NP								
Robins	8	1	47	190.6	0	23	0.008	0.68
Dandari	0	0	0	0.0	0	0	0.000	0.18
Shakwanki	0	0	0	0.0	0	0	0.000	0.00
Dzivanini	26	2	311	145.9	0	64	0.012	0.33
Sinamatella	17	2	128	139.0	0	41	0.011	0.63
Mtoa	9	1	69	190.6	0	27	0.011	1.34
Main Camp	19	3	180	143.0	0	47	0.015	1.36
Shapi	0	0	0	0.0	0	0	0.000	0.00
Central B	0	0	0	0.0	0	0	0.000	0.00
Central A	0	0	0	0.0	0	0	0.000	0.00
Ngamo	0	0	0	0.0	0	0	0.000	0.00
Subtotals	80	9	736	68.4	25	134	0.005	0.30
Communal Areas								
Tsholotsho East	0	0	0	0.0	0	0	0.000	0.00
Maitengwe	0	0	0	0.0	0	0	0.000	-
Tsholotsho Far North	0	0	0	0.0	0	0	0.000	0.00
Subtotals	0	0	0	0.0	0	0	0.000	0.00
Forest Areas								
Ngamo Forest	0	0	0	0.0	0	0	0.000	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.000	0.00
Subtotals	0	0	0	0.0	0	0	0.000	0.00
Totals	128	16	900	46.8	68	188	0.005	0.38



Map 7. Distribution of elephant carcasses (age category 1 or 2) in NW Matabeleland during October-November 2007



Map 8. Distribution of elephant all-carcass ratios and age category 3 or 4 carcasses in NW Matabeleland during October-November 2007

Table 7. Population estimates and statistics for Elephant Carcasses 3 in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.000
Kazungula	28	4	305	135.7	0	65	0.062
Panda Masuie	0	0	0	0.0	0	0	0.000
Kazuma	41	3	605	147.1	0	101	0.073
Matetsi	19	1	285	225.5	0	63	0.027
Rosslyn	0	0	0	0.0	0	0	0.000
Zanguja	0	0	0	0.0	0	0	0.000
Subtotals	88	8	1195	83.1	15	161	0.020
Hwange NP							
Robins	0	0	0	0.0	0	0	0.000
Dandari	0	0	0	0.0	0	0	0.000
Shakwanki	0	0	0	0.0	0	0	0.000
Dzivanini	0	0	0	0.0	0	0	0.000
Sinamatella	17	2	126	138.0	0	41	0.011
Mtoa	9	1	78	201.9	0	28	0.011
Main Camp	0	0	0	0.0	0	0	0.000
Shapi	0	0	0	0.0	0	0	0.000
Central B	0	0	0	0.0	0	0	0.000
Central A	0	0	0	0.0	0	0	0.000
Ngamo	0	0	0	0.0	0	0	0.000
Subtotals	26	3	204	110.5	0	55	0.002
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.000
Maitengwe	0	0	0	0.0	0	0	0.000
Tsholotsho Far North	0	0	0	0.0	0	0	0.000
Subtotals	0	0	0	0.0	0	0	0.000
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.000
Sikumi Forest	40	2	1405	216.6	0	126	0.034
Subtotals	40	2	1405	216.6	0	126	0.017
Totals	154	13	2805	71.2	44	263	0.006

Table 8. Population estimates and statistics for Elephant Carcasses 4 in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)	All Carcass Ratio (%)
Matetsi Complex								
Zambezi NP	142	11	1388	64.4	50	233	0.261	29.0
Kazungula	104	15	1028	66.4	35	172	0.232	54.2
Panda Masuie	128	9	2808	92.1	10	246	0.133	21.9
Kazuma	95	7	997	80.9	18	173	0.170	100.0
Matetsi	39	2	501	149.4	0	96	0.055	20.1
Rosslyn	56	4	684	128.7	0	129	0.164	80.0
Zanguja	31	2	203	109.8	0	64	0.037	4.7
Subtotals	594	50	7608	29.7	418	771	0.135	28.5
Hwange NP								
Robins	117	15	715	49.4	59	175	0.114	9.6
Dandari	149	17	1846	59.7	60	237	0.115	3.1
Shakwanki	95	5	1510	91.3	8	181	0.044	3.9
Dzivanini	65	5	913	100.0	0	131	0.031	1.1
Sinamatella	162	19	1501	50.1	81	243	0.106	6.8
Mtoa	138	15	1345	56.0	61	215	0.167	11.1
Main Camp	182	28	1973	50.7	90	274	0.144	9.9
Shapi	78	9	470	57.8	33	124	0.085	1.3
Central B	31	1	978	321.7	0	130	0.018	1.0
Central A	35	3	280	104.9	0	72	0.045	2.6
Ngamo	198	26	796	29.6	139	257	0.122	10.4
Subtotals	1250	143	12327	17.6	1030	1470	0.082	3.9
Communal Areas								
Tsholotsho East	40	2	630	143.2	0	98	0.044	5.5
Maitengwe	28	1	605	222.4	0	92	0.023	100.0
Tsholotsho Far North	87	3	939	83.0	15	160	0.184	37.3
Subtotals	156	6	2174	62.7	58	254	0.060	15.8
Forest Areas								
Ngamo Forest	57	2	772	136.1	0	134	0.048	2.5
Sikumi Forest	200	10	4493	77.4	45	354	0.170	28.6
Subtotals	256	12	5265	63.1	95	418	0.109	9.6
Totals	2257	211	27374	14.5	1929	2584	0.092	6.1

Table 9. Population estimates and statistics for Unidentified Carcasses in north-west Matabeleland

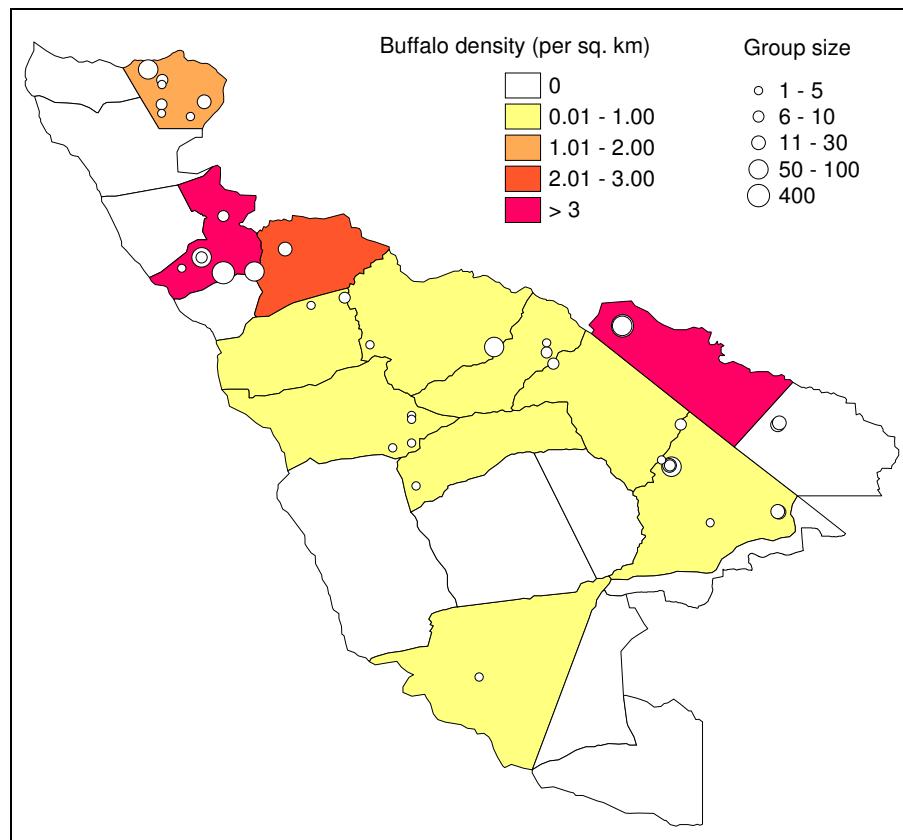
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	51	4	294	81.5	10	93	0.095
Kazungula	90	13	569	57.0	39	141	0.201
Panda Masuie	71	5	1001	99.0	1	142	0.074
Kazuma	68	5	456	76.6	16	120	0.122
Matetsi	39	2	416	136.2	0	91	0.055
Rosslyn	28	2	136	114.9	0	61	0.082
Zanguja	77	5	770	85.5	11	142	0.091
Subtotals	424	36	3643	28.7	303	546	0.096
Hwange NP							
Robins	70	9	801	87.2	9	131	0.068
Dandari	9	1	64	188.9	0	25	0.007
Shakwanki	0	0	0	0.0	0	0	0.000
Dzivanini	52	4	462	88.9	6	99	0.025
Sinamatella	145	17	766	40.0	87	203	0.095
Mtoa	55	6	389	75.4	14	97	0.067
Main Camp	65	10	501	71.5	19	111	0.052
Shapi	52	6	343	74.0	14	91	0.057
Central B	0	0	0	0.0	0	0	0.000
Central A	12	1	116	202.2	0	35	0.015
Ngamo	183	24	1738	47.4	96	270	0.112
Subtotals	643	78	5180	22.2	500	786	0.042
Communal Areas							
Tsholotsho East	40	2	590	138.6	0	96	0.044
Maitengwe	28	1	560	214.1	0	89	0.023
Tsholotsho Far North	0	0	0	0.0	0	0	0.000
Subtotals	69	3	1151	107.4	0	143	0.026
Forest Areas							
Ngamo Forest	312	11	31469	158.0	0	804	0.266
Sikumi Forest	100	5	1652	93.9	6	194	0.085
Subtotals	412	16	33122	122.8	0	917	0.176
Totals	1547	133	43095	31.7	1056	2038	0.063

Table 10. Population estimates and statistics for Buffalo in north-west Matabeleland

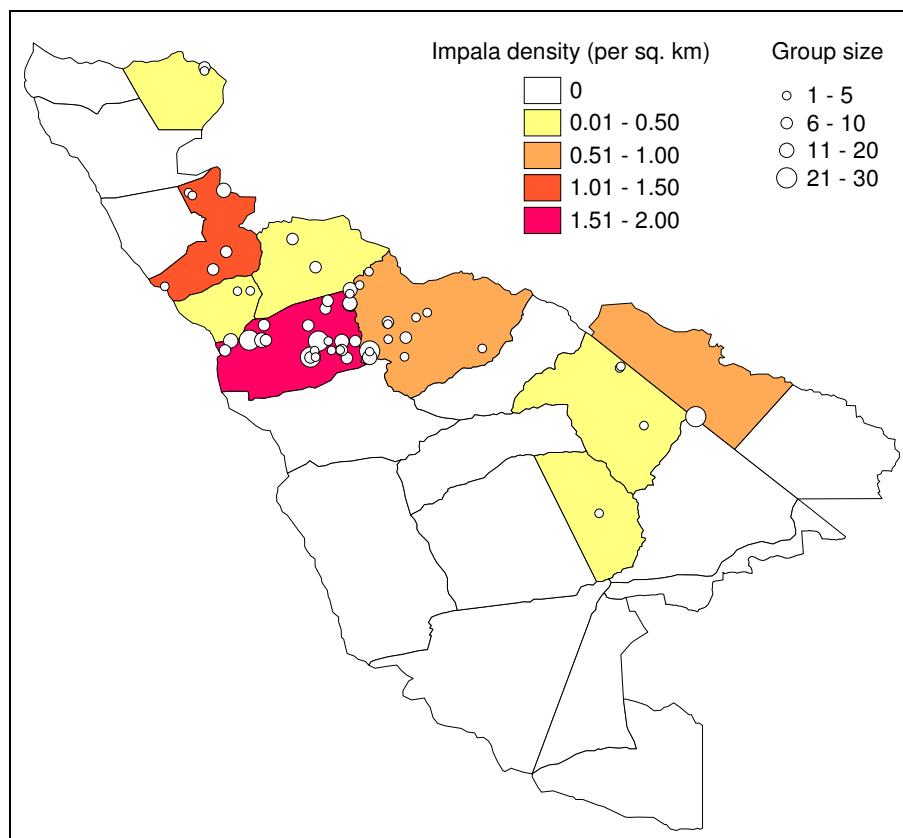
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	1055	82	406733	147.9	0	2616	1.94
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	9683	503	99264049	264.5	0	35298	13.77
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	1688	110	1233481	155.6	0	4315	2.01
Subtotals	12427	695	100904264	207.8	0	38248	2.82
Hwange NP							
Robins	62	8	2804	183.5	0	177	0.06
Dandari	96	11	5636	161.2	0	251	0.07
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	13	1	155	206.0	0	40	0.01
Sinamatella	452	53	160657	185.7	0	1291	0.30
Mtoa	92	10	7027	192.1	0	269	0.11
Main Camp	104	16	4597	135.3	0	245	0.08
Shapi	26	3	523	182.7	0	74	0.03
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	1402	184	879618	139.2	0	3352	0.86
Subtotals	2247	286	1061015	93.8	140	4354	0.15
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	850	30	561701	244.7	0	2931	0.73
Sikumi Forest	8982	450	81853462	232.3	0	29845	7.66
Subtotals	9832	480	82415164	212.9	0	30767	4.19
Totals	24506	1461	184380443	120.7	0	54091	1.00

Table 11. Population estimates and statistics for Impala in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	116	9	13703	247.3	0	402	0.21
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	770	40	120696	116.0	0	1663	1.10
Rosslyn	85	6	5103	234.3	0	283	0.25
Zanguja	200	13	10265	120.1	0	439	0.24
Subtotals	1170	68	149766	78.2	255	2085	0.27
Hwange NP							
Robins	1815	233	829820	108.4	0	3783	1.76
Dandari	0	0	0	0.0	0	0	0.00
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	1125	132	291508	100.4	0	2255	0.74
Mtoa	0	0	0	0.0	0	0	0.00
Main Camp	39	6	713	142.1	0	94	0.03
Shapi	0	0	0	0.0	0	0	0.00
Central B	0	0	0	0.0	0	0	0.00
Central A	35	3	1005	198.8	0	105	0.05
Ngamo	0	0	0	0.0	0	0	0.00
Subtotals	3015	374	1123046	73.1	811	5218	0.20
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	599	30	339911	224.5	0	1943	0.51
Subtotals	599	30	339911	224.5	0	1943	0.26
Totals	4783	472	1612723	54.0	2203	7364	0.19



Map 9. Distribution of buffalo in NW Matabeleland during October-November 2007



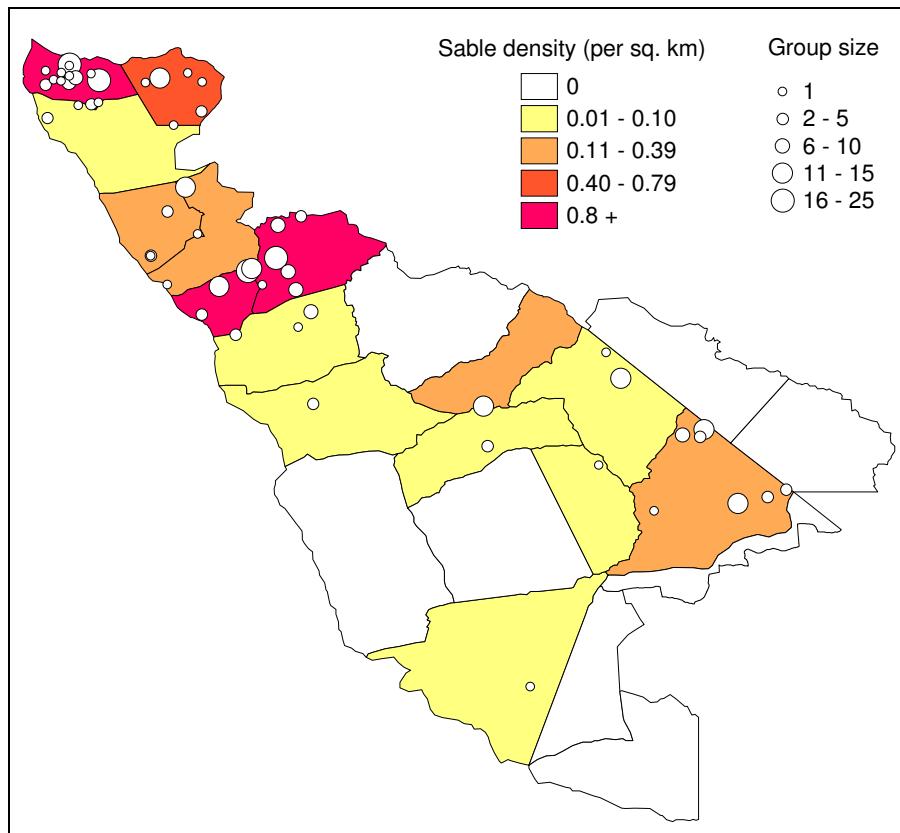
Map 10. Distribution of impala in NW Matabeleland during October-November 2007

Table 12. Population estimates and statistics for Sable in north-west Matabeleland

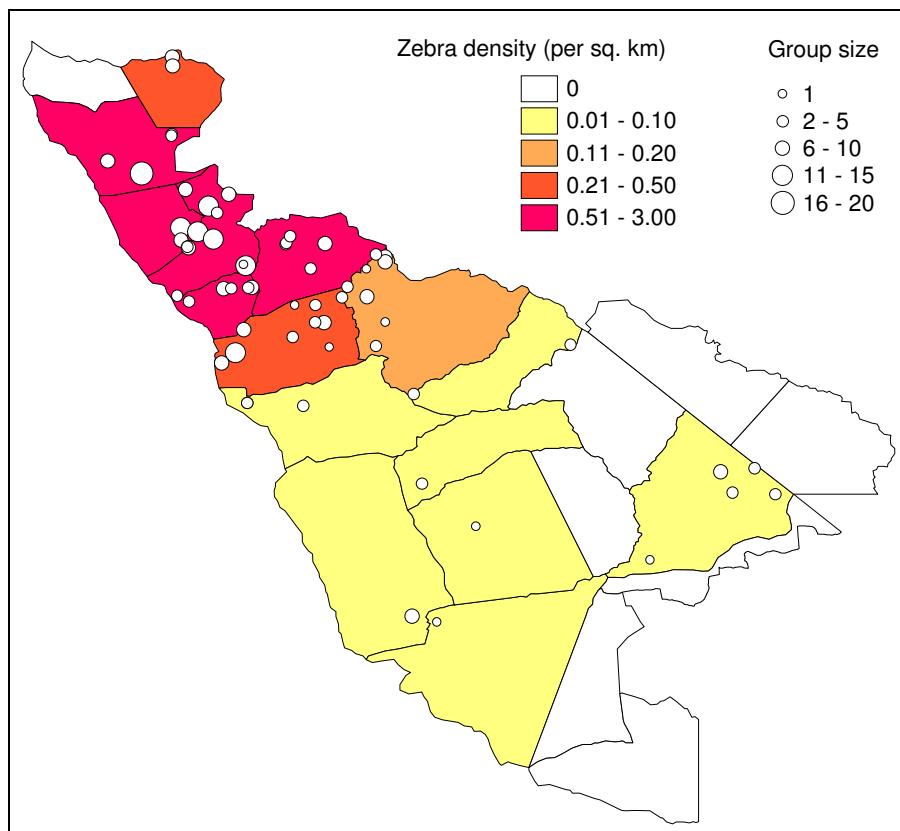
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	270	21	20401	129.3	0	620	0.50
Kazungula	525	76	65073	104.3	0	1072	1.18
Panda Masuie	57	4	2196	183.4	0	161	0.06
Kazuma	82	6	1263	106.3	0	169	0.15
Matetsi	250	13	39389	203.9	0	761	0.36
Rosslyn	522	37	103876	171.4	0	1417	1.52
Zanguja	921	60	109524	85.0	138	1704	1.10
Subtotals	2627	217	341722	46.0	1417	3836	0.60
Hwange NP							
Robins	93	12	3048	127.5	0	213	0.09
Dandari	35	4	1048	191.2	0	102	0.03
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	13	1	155	206.0	0	40	0.01
Sinamatella	0	0	0	0.0	0	0	0.00
Mtoa	101	11	8796	195.4	0	299	0.12
Main Camp	104	16	8330	182.1	0	293	0.08
Shapi	17	2	233	183.1	0	49	0.02
Central B	0	0	0	0.0	0	0	0.00
Central A	12	1	116	202.2	0	35	0.02
Ngamo	366	48	27369	94.1	22	710	0.22
Subtotals	741	95	49094	59.9	297	1186	0.05
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	3368	312	390816	37.9	2093	4643	0.14

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

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	193	15	33847	233.2	0	643	0.36
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	513	36	68586	113.9	0	1096	0.53
Kazuma	505	37	126863	172.7	0	1376	0.90
Matetsi	1290	67	107073	65.2	448	2131	1.84
Rosslyn	367	26	60698	186.5	0	1051	1.07
Zanguja	491	32	48249	105.8	0	1011	0.59
Subtotals	3358	213	445316	40.7	1991	4725	0.76
Hwange NP							
Robins	405	52	10608	54.9	183	628	0.39
Dandari	131	15	8666	146.6	0	323	0.10
Shakwanki	114	6	11704	211.7	0	355	0.05
Dzivanini	13	1	156	206.5	0	40	0.01
Sinamatella	298	35	22403	105.0	0	612	0.20
Mtoa	55	6	1590	152.3	0	139	0.07
Main Camp	0	0	0	0.0	0	0	0.00
Shapi	26	3	517	181.7	0	74	0.03
Central B	31	1	978	321.7	0	130	0.02
Central A	0	0	0	0.0	0	0	0.00
Ngamo	129	17	3419	93.9	8	251	0.08
Subtotals	1203	136	60041	40.6	714	1692	0.08
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	4561	349	505357	31.6	3121	6001	0.19



Map 11. Distribution of sable antelope in NW Matabeleland during October-November 2007



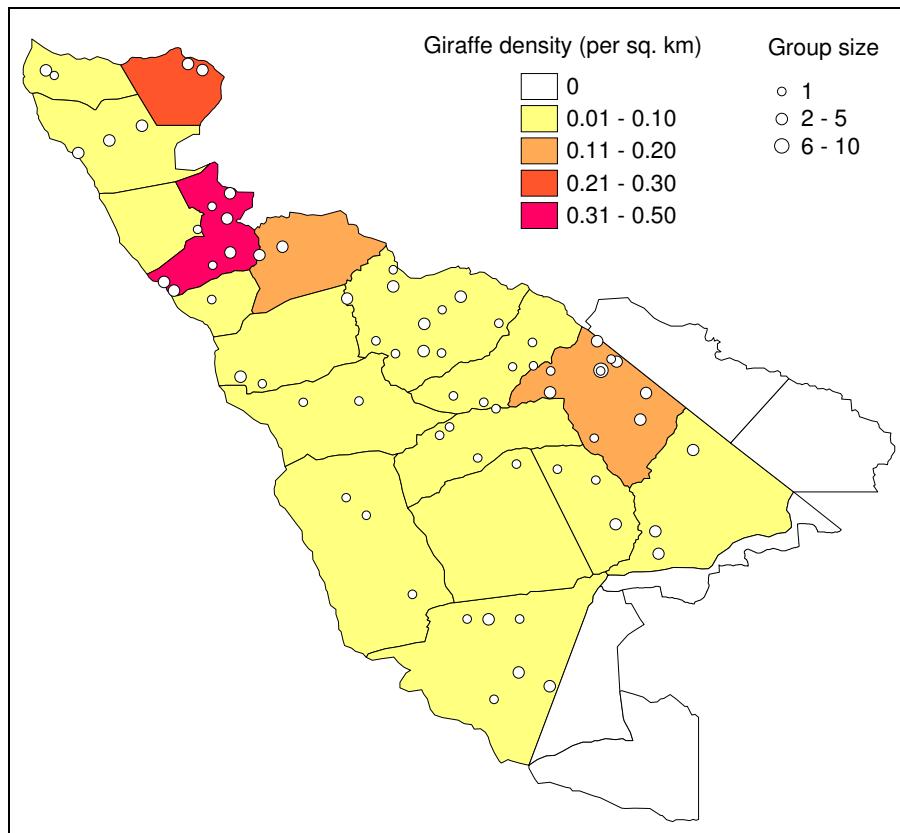
Map 12. Distribution of zebra in NW Matabeleland during October-November 2007

Table 14. Population estimates and statistics for Giraffe in north-west Matabeleland

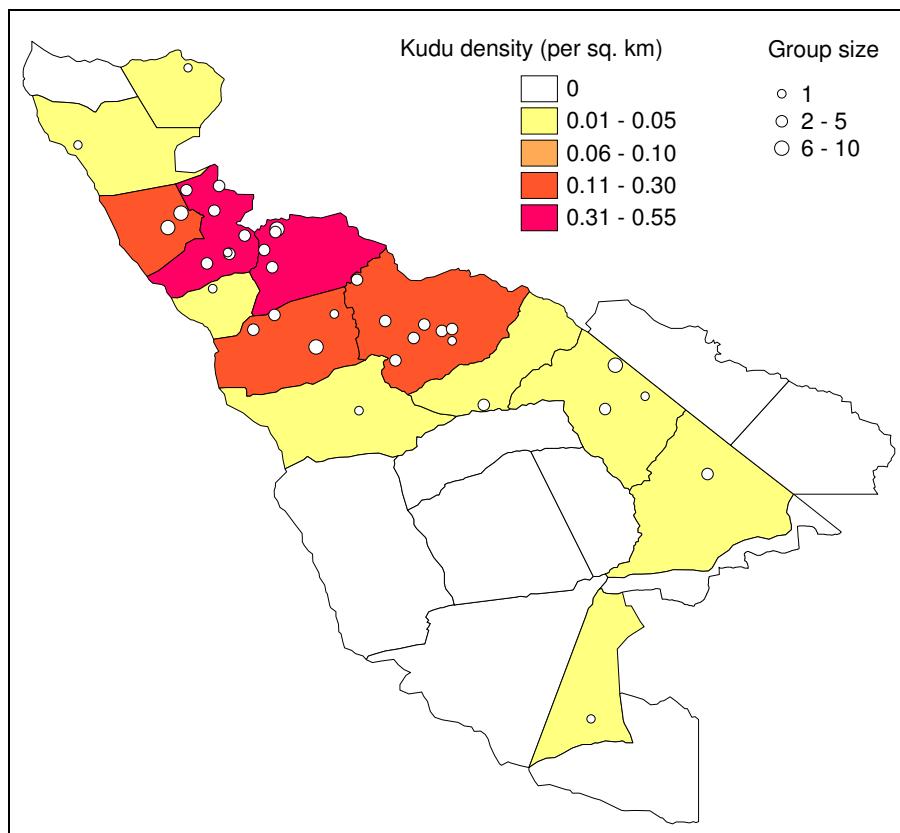
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	116	9	5399	155.2	0	296	0.21
Kazungula	28	4	394	154.2	0	70	0.06
Panda Masuie	100	7	2384	109.2	0	208	0.10
Kazuma	14	1	209	259.1	0	49	0.02
Matetsi	327	17	10393	80.1	65	589	0.47
Rosslyn	14	1	103	199.9	0	42	0.04
Zanguja	92	6	2970	139.9	0	221	0.11
Subtotals	690	45	21852	45.4	377	1004	0.16
Hwange NP							
Robins	31	4	486	152.8	0	79	0.03
Dandari	17	2	120	129.5	0	40	0.01
Shakwanki	57	3	664	100.9	0	114	0.03
Dzivanini	117	9	2908	99.1	1	234	0.06
Sinamatella	136	16	2042	69.4	42	231	0.09
Mtoa	46	5	378	89.1	5	87	0.06
Main Camp	156	24	5204	96.0	6	306	0.12
Shapi	35	4	182	80.8	7	63	0.04
Central B	31	1	910	310.3	0	127	0.02
Central A	70	6	1843	134.6	0	165	0.09
Ngamo	84	11	2117	114.2	0	179	0.05
Subtotals	781	85	16854	33.0	523	1039	0.05
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	1471	130	38706	26.9	1076	1867	0.06

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

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	13	1	162	241.7	0	44	0.02
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	14	1	209	226.2	0	46	0.02
Kazuma	164	12	9260	143.9	0	399	0.29
Matetsi	385	20	12764	75.4	95	675	0.55
Rosslyn	14	1	142	234.3	0	47	0.04
Zanguja	261	17	28250	152.3	0	658	0.31
Subtotals	851	52	50787	55.9	375	1326	0.19
Hwange NP							
Robins	109	14	3545	117.9	0	238	0.11
Dandari	9	1	64	189.0	0	25	0.01
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	196	23	3020	58.7	81	311	0.13
Mtoa	18	2	291	195.4	0	54	0.02
Main Camp	65	10	1920	139.9	0	156	0.05
Shapi	0	0	0	0.0	0	0	0.00
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	15	2	204	195.0	0	45	0.01
Subtotals	412	52	9044	46.3	221	603	0.03
Communal Areas							
Tsholotsho East	20	1	298	197.1	0	60	0.02
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	20	1	298	197.1	0	60	0.01
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	1283	105	60129	39.4	777	1790	0.05



Map 13. Distribution of giraffe in NW Matabeleland during October-November 2007



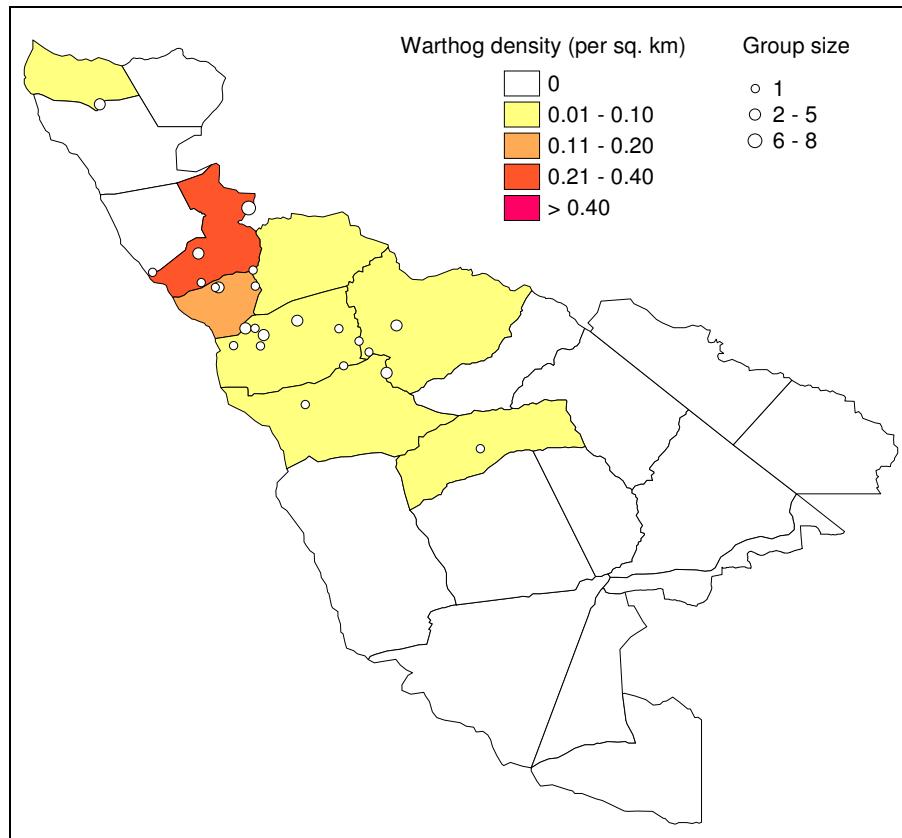
Map 14. Distribution of kudu in NW Matabeleland during October-November 2007

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

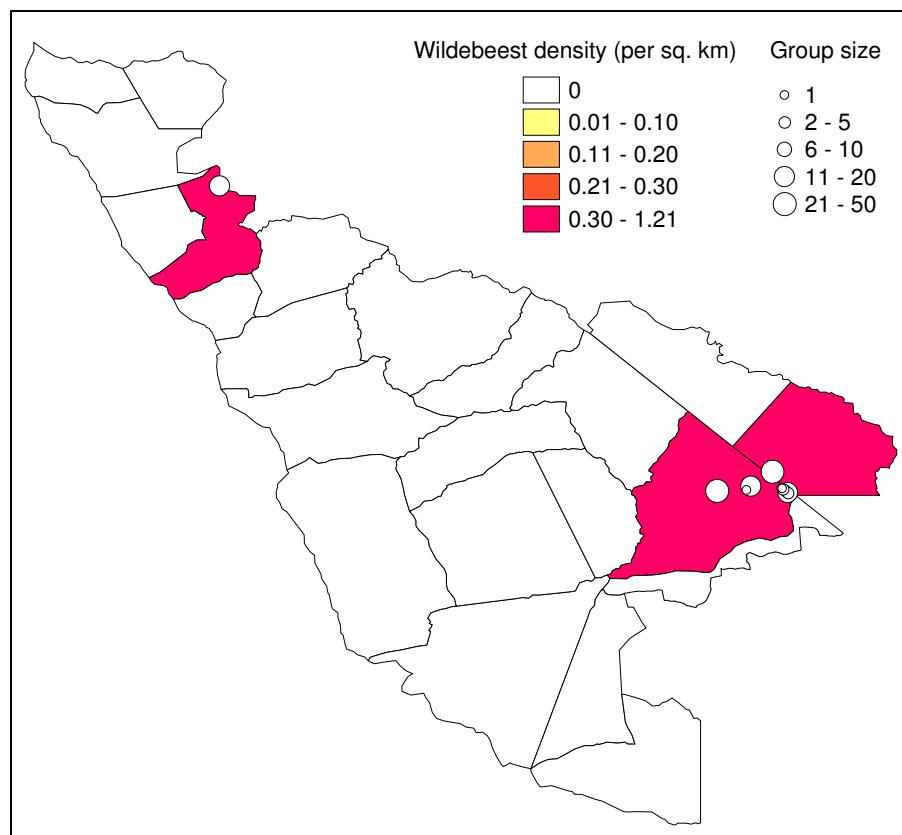
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	14	2	168	201.5	0	42	0.03
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	231	12	23511	170.7	0	625	0.33
Rosslyn	56	4	2268	234.3	0	189	0.16
Zanguja	15	1	187	210.6	0	48	0.02
Subtotals	317	19	26134	125.0	0	712	0.07
Hwange NP							
Robins	93	12	1449	87.9	11	176	0.09
Dandari	17	2	120	129.6	0	40	0.01
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	68	8	1102	101.9	0	138	0.05
Mtoa	0	0	0	0.0	0	0	0.00
Main Camp	0	0	0	0.0	0	0	0.00
Shapi	9	1	58	182.1	0	25	0.01
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	0	0	0	0.0	0	0	0.00
Subtotals	188	23	2730	56.6	81	294	0.01
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	504	42	28863	79.6	103	906	0.02

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

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	231	12	54553	260.0	0	831	0.33
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	0	0	0	0.0	0	0	0.00
Subtotals	231	12	54553	259.9	0	831	0.05
Hwange NP							
Robins	0	0	0	0.0	0	0	0.00
Dandari	0	0	0	0.0	0	0	0.00
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	0	0	0	0.0	0	0	0.00
Mtoa	0	0	0	0.0	0	0	0.00
Main Camp	0	0	0	0.0	0	0	0.00
Shapi	0	0	0	0.0	0	0	0.00
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	670	88	129269	111.6	0	1418	0.41
Subtotals	670	88	129269	111.5	0	1418	0.04
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	1417	50	1468574	237.4	0	4781	1.21
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	1417	50	1468574	237.4	0	4782	0.60
Totals	2318	150	1652396	142.5	0	5623	0.09



Map 15. Distribution of warthog in NW Matabeleland during October-November 2007



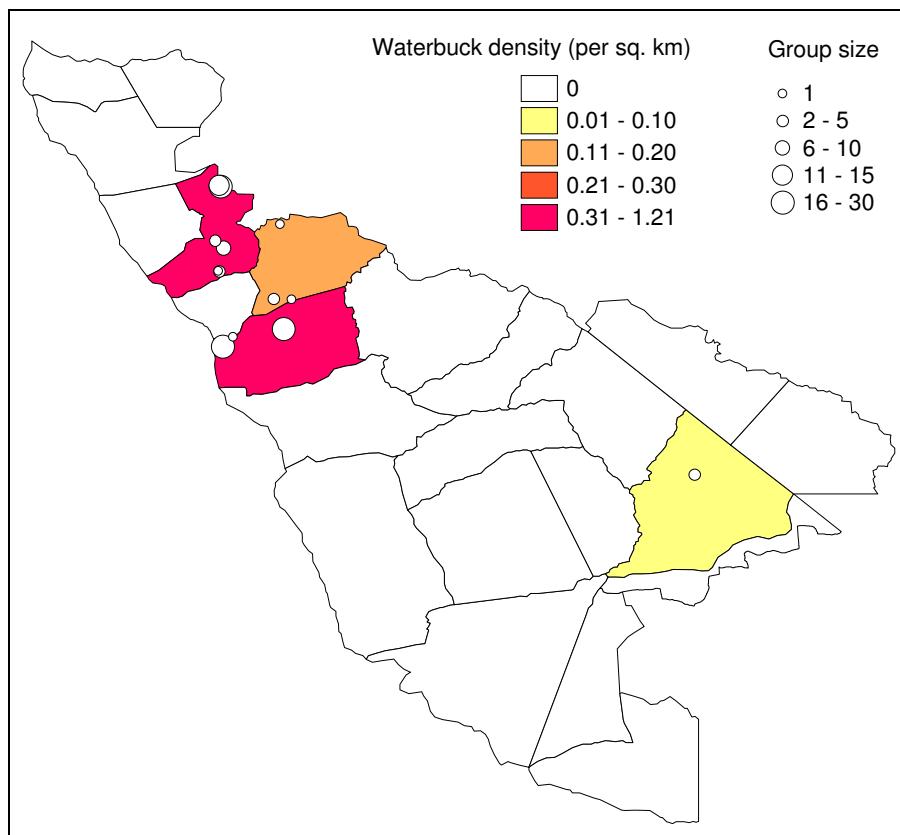
Map 16. Distribution of wildebeest in NW Matabeleland during October-November 2007

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

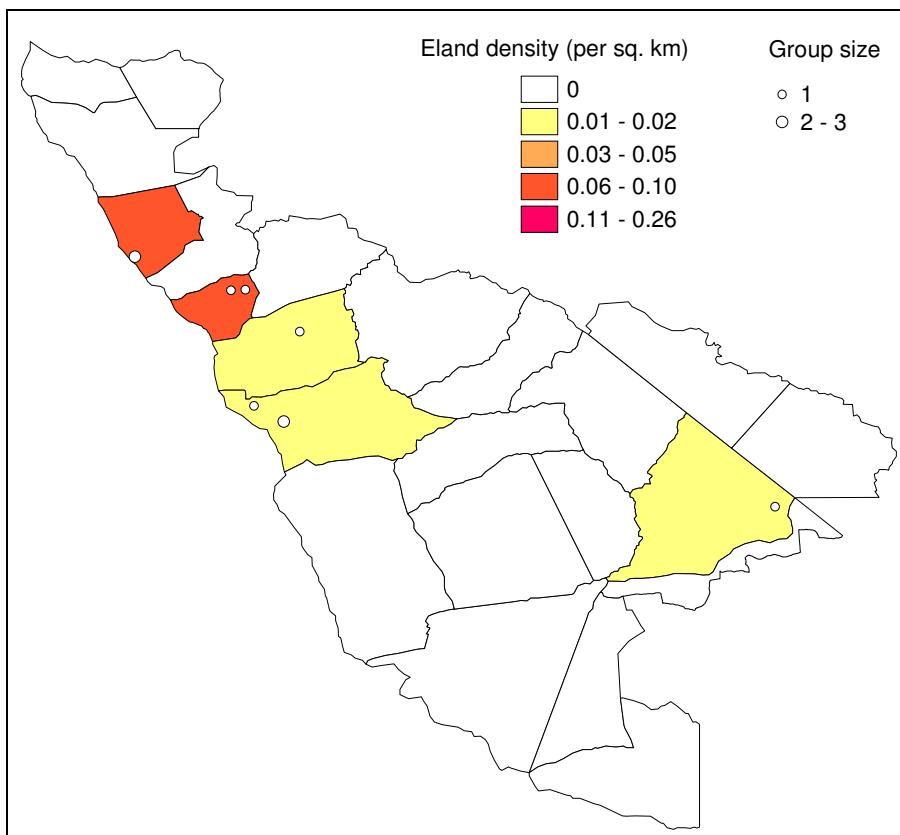
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	847	44	314068	170.1	0	2288	1.21
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	107	7	3076	122.1	0	239	0.13
Subtotals	954	51	317143	151.7	0	2402	0.22
Hwange NP							
Robins	397	51	55261	127.8	0	905	0.39
Dandari	0	0	0	0.0	0	0	0.00
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	0	0	0	0.0	0	0	0.00
Mtoa	0	0	0	0.0	0	0	0.00
Main Camp	0	0	0	0.0	0	0	0.00
Shapi	0	0	0	0.0	0	0	0.00
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	38	5	1281	195.5	0	113	0.02
Subtotals	435	56	56542	118.0	0	949	0.03
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	1390	107	373686	107.6	0	2886	0.06

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

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	41	3	1494	231.1	0	135	0.07
Matetsi	0	0	0	0.0	0	0	0.00
Rosslyn	28	2	567	234.3	0	94	0.08
Zanguja	0	0	0	0.0	0	0	0.00
Subtotals	69	5	2061	148.6	0	172	0.02
Hwange NP							
Robins	8	1	50	195.3	0	23	0.01
Dandari	26	3	325	142.0	0	63	0.02
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	0	0	0	0.0	0	0	0.00
Mtoa	0	0	0	0.0	0	0	0.00
Main Camp	0	0	0	0.0	0	0	0.00
Shapi	0	0	0	0.0	0	0	0.00
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	8	1	52	196.1	0	23	0.01
Subtotals	42	5	426	100.4	0	83	0.003
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	111	10	2487	97.3	3	218	0.005



Map 17. Distribution of waterbuck in NW Matabeleland during October-November 2007



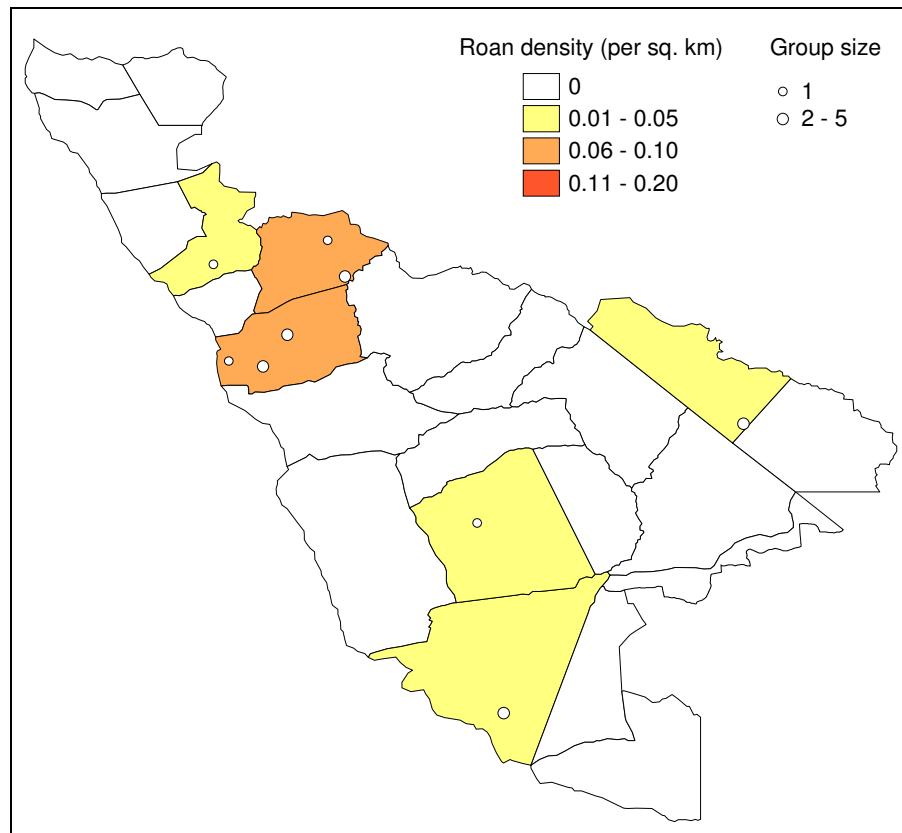
Map 18. Distribution of eland in NW Matabeleland during October-November 2007

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

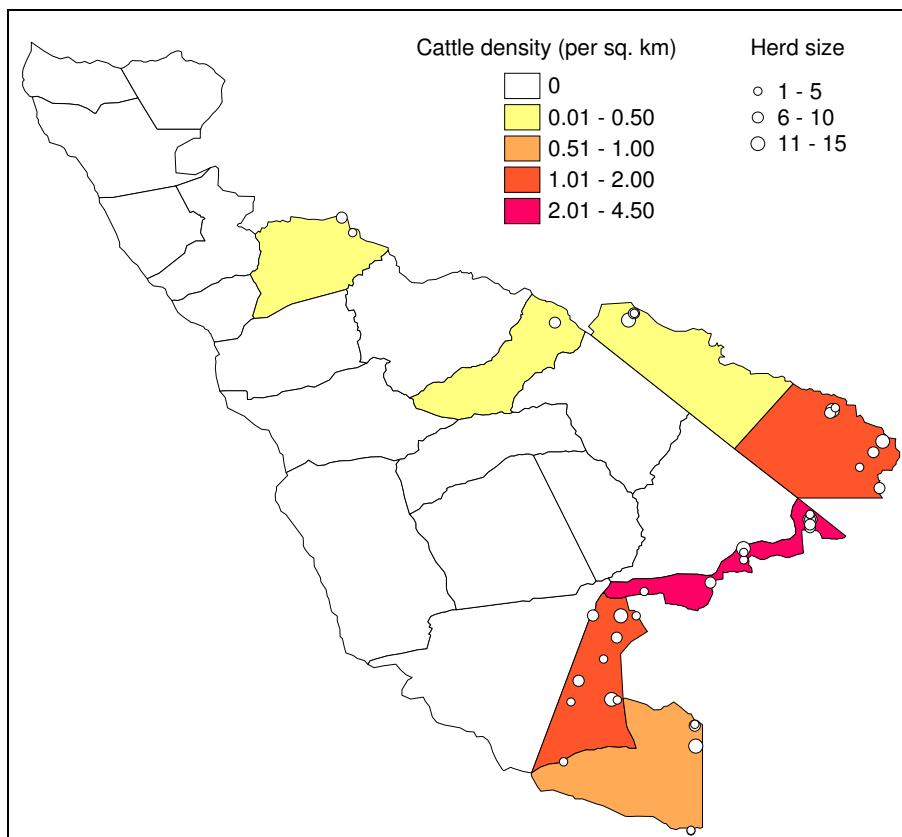
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	19	1	421	274.2	0	72	0.03
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	61	4	1643	156.1	0	157	0.07
Subtotals	81	5	2065	124.0	0	181	0.02
Hwange NP							
Robins	70	9	1436	116.7	0	152	0.07
Dandari	0	0	0	0.0	0	0	0.00
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	52	4	2629	212.1	0	163	0.03
Sinamatella	0	0	0	0.0	0	0	0.00
Mtoa	0	0	0	0.0	0	0	0.00
Main Camp	0	0	0	0.0	0	0	0.00
Shapi	0	0	0	0.0	0	0	0.00
Central B	31	1	978	321.7	0	130	0.02
Central A	0	0	0	0.0	0	0	0.00
Ngamo	0	0	0	0.0	0	0	0.00
Subtotals	153	14	5043	95.4	7	300	0.01
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	40	2	1405	216.6	0	126	0.03
Subtotals	40	2	1405	216.6	0	126	0.02
Totals	274	21	8513	67.9	88	460	0.01

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

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	0	0	0	0.0	0	0	0.00
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	153	10	6485	124.1	0	344	0.18
Subtotals	153	10	6485	121.0	0	339	0.03
Hwange NP							
Robins	0	0	0	0.0	0	0	0.00
Dandari	0	0	0	0.0	0	0	0.00
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	0	0	0	0.0	0	0	0.00
Mtoa	64	7	3529	194.5	0	190	0.08
Main Camp	0	0	0	0.0	0	0	0.00
Shapi	0	0	0	0.0	0	0	0.00
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	0	0	0	0.0	0	0	0.00
Subtotals	64	7	3529	194.4	0	190	0.004
Communal Areas							
Tsholotsho East	1111	55	245854	102.9	0	2255	1.22
Maitengwe	910	32	506421	201.1	0	2739	0.74
Tsholotsho Far North	2125	73	1501564	136.4	0	5023	4.48
Subtotals	4146	160	2253840	78.2	903	7389	1.59
Forest Areas							
Ngamo Forest	1700	60	637767	130.4	0	3917	1.45
Sikumi Forest	459	23	213830	232.3	0	1525	0.39
Subtotals	2159	83	851596	104.6	0	4418	0.92
Totals	6523	260	3115450	56.6	2829	10218	0.27



Map 19. Distribution of roan antelope in NW Matabeleland during October-November 2007



Map 20. Distribution of cattle in NW Matabeleland during October-November 2007

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

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	0	0	0	0.0	0	0	0.00
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Hwange NP							
Robins	0	0	0	0.0	0	0	0.00
Dandari	0	0	0	0.0	0	0	0.00
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	0	0	0	0.0	0	0	0.00
Mtoa	0	0	0	0.0	0	0	0.00
Main Camp	0	0	0	0.0	0	0	0.00
Shapi	0	0	0	0.0	0	0	0.00
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Communal Areas							
Tsholotsho East	20	1	358	215.8	0	64	0.02
Maitengwe	142	5	14011	214.1	0	446	0.12
Tsholotsho Far North	728	25	197906	144.6	0	1780	1.54
Subtotals	890	31	212274	122.4	0	1979	0.34
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	890	31	212274	122.4	0	1979	0.04

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

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	0	0	0	0.0	0	0	0.00
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Hwange NP							
Robins	0	0	0	0.0	0	0	0.00
Dandari	0	0	0	0.0	0	0	0.00
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	0	0	0	0.0	0	0	0.00
Mtoa	0	0	0	0.0	0	0	0.00
Main Camp	0	0	0	0.0	0	0	0.00
Shapi	0	0	0	0.0	0	0	0.00
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Communal Areas							
Tsholotsho East	40	2	1430	215.8	0	128	0.04
Maitengwe	28	1	533	208.8	0	88	0.02
Tsholotsho Far North	262	9	25254	143.5	0	638	0.55
Subtotals	331	12	27217	115.0	0	711	0.13
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	331	12	27217	115.0	0	711	0.01

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

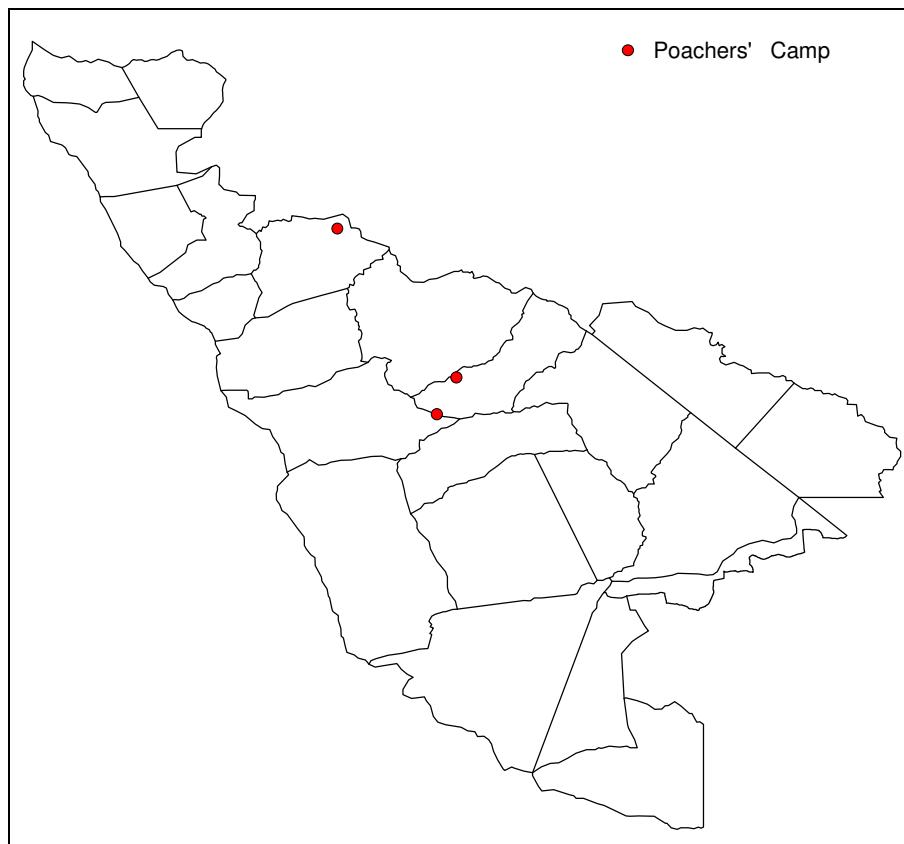
Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	28	2	727	211.0	0	89	0.03
Kazuma	27	2	614	222.3	0	88	0.05
Matetsi	0	0	0	0.0	0	0	0.00
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	0	0	0	0.0	0	0	0.00
Subtotals	56	4	1341	140.0	0	134	0.01
Hwange NP							
Robins	31	4	466	149.5	0	78	0.03
Dandari	9	1	65	191.0	0	25	0.01
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	0	0	0	0.0	0	0	0.00
Mtoa	0	0	0	0.0	0	0	0.00
Main Camp	32	5	930	194.8	0	96	0.03
Shapi	0	0	0	0.0	0	0	0.00
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	15	2	206	196.2	0	45	0.01
Subtotals	88	12	1667	93.8	5	170	0.01
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	143	16	3008	76.8	33	253	0.01

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

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	55	4	2455	222.3	0	176	0.10
Matetsi	0	0	0	0.0	0	0	0.00
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	0	0	0	0.0	0	0	0.00
Subtotals	55	4	2455	222.3	0	176	0.01
Hwange NP							
Robins	0	0	0	0.0	0	0	0.00
Dandari	35	4	1048	191.2	0	102	0.03
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	26	2	657	212.1	0	81	0.01
Sinamatella	43	5	749	134.4	0	100	0.03
Mtoa	0	0	0	0.0	0	0	0.00
Main Camp	19	3	337	195.3	0	58	0.02
Shapi	26	3	529	183.9	0	74	0.03
Central B	31	1	910	310.3	0	127	0.02
Central A	0	0	0	0.0	0	0	0.00
Ngamo	30	4	483	150.0	0	76	0.02
Subtotals	211	22	4714	65.4	73	348	0.01
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	265	26	7169	64.7	93	437	0.01

Table 26. Population estimates and statistics for Poachers' Camps in north-west Matabeleland

Stratum	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi Complex							
Zambezi NP	0	0	0	0.0	0	0	0.00
Kazungula	0	0	0	0.0	0	0	0.00
Panda Masuie	0	0	0	0.0	0	0	0.00
Kazuma	0	0	0	0.0	0	0	0.00
Matetsi	0	0	0	0.0	0	0	0.00
Rosslyn	0	0	0	0.0	0	0	0.00
Zanguja	15	1	155	191.9	0	45	0.02
Subtotals	15	1	155	187.1	0	44	0.003
Hwange NP							
Robins	0	0	0	0.0	0	0	0.00
Dandari	0	0	0	0.0	0	0	0.00
Shakwanki	0	0	0	0.0	0	0	0.00
Dzivanini	0	0	0	0.0	0	0	0.00
Sinamatella	0	0	0	0.0	0	0	0.00
Mtoa	18	2	146	138.4	0	44	0.02
Main Camp	0	0	0	0.0	0	0	0.00
Shapi	0	0	0	0.0	0	0	0.00
Central B	0	0	0	0.0	0	0	0.00
Central A	0	0	0	0.0	0	0	0.00
Ngamo	0	0	0	0.0	0	0	0.00
Subtotals	18	2	146	138.4	0	44	0.001
Communal Areas							
Tsholotsho East	0	0	0	0.0	0	0	0.00
Maitengwe	0	0	0	0.0	0	0	0.00
Tsholotsho Far North	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0.00
Sikumi Forest	0	0	0	0.0	0	0	0.00
Subtotals	0	0	0	0.0	0	0	0.00
Totals	34	3	301	106.9	0	70	0.001



Map 21. Distribution of poachers' camps in NW Matabeleland during October-November 2007

Appendix 1. Calibration of strip width

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

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

¹ agl: above ground level

Calibration 1

Calibration flights during 27-31 October 2007 at Hwange Main Camp airstrip

Run no.	Left observer: Godfrey Mtare			Right observer: Colin Zhuwau			Combined strip width (m) at flying height	Flying height agl (ft)	Combined strip width (m) when flying at 300 ft
	Outer marker	Inner marker	Strip width (m)	Outer marker	Inner marker	Strip width (m)			
1	18	6	130	20	5	160	290	300	290
2	19	4	160	22	7	160	320	300	320
3	21	6	160	19	7	130	290	300	290
4	21	4	180	23	8	160	340	300	340
5	23	3	210	18	5	140	350	250	420
6	20	5	160	26	5	220	380	250	456
7	24	6	190	23	7	170	360	300	360
8	22	5	180	25	10	160	340	330	309
9	22	6	170	29	11	190	360	350	309
10	29	10	200	22	7	160	360	350	309
11	20	5	160	27	13	150	310	300	310
12	21	4	180	24	11	140	320	300	320
13	25	9	170	22	7	160	330	270	367
14	20	6	150	23	8	160	310	290	321
15	28	7	220	25	8	180	400	300	400
16	25	9	170	23	6	180	350	300	350
17	24	5	200	25	8	180	380	280	407
18	29	8	220	24	9	160	380	350	326
19	28	10	190	18	4	150	340	300	340
20	25	9	170	20	3	180	350	290	362
21	25	11	150	19	4	160	310	300	310
22	25	7	190	22	6	170	360	300	360
23	24	9	160	20	4	170	330	280	354
24	28	10	190	21	4	180	370	300	370
25	21	6	160	27	7	210	370	290	383
26	20	5	160	25	9	170	330	300	330
27	25	9	170	24	3	220	390	280	418
28	28	10	190	25	8	180	370	330	336
29	29	11	190	19	4	160	350	300	350

Run no.	Left observer: Godfrey Mtare			Right observer: Colin Zhuwau			Combined strip width (m) at flying height	Flying height agl (ft)	Combined strip width (m) when flying at 300 ft
	Outer marker	Inner marker	Strip width (m)	Outer marker	Inner marker	Strip width (m)			
30	30	13	180	25	5	210	390	290	403
31	24	8	170	25	11	150	320	300	320
32	20	4	170	29	11	190	360	310	348
33	19	5	150	21	7	150	300	300	300
34	24	8	170	19	7	130	300	300	300
35	30	11	200	26	11	160	360	290	372
36	26	12	150	18	5	140	290	300	290
37	23	9	150	22	7	160	310	270	344
38	22	6	170	24	8	170	340	300	340
39	25	10	160	18	4	150	310	280	332
40	28	10	190	20	6	150	340	290	352
41	22	7	160	22	7	160	320	280	343
42	26	11	160	20	5	160	320	290	331

This first calibration exercise did not – for one observer - produce a positive linear relationship between the observer's actual strip width and flying height. Hence, the calibration exercise was repeated (below).

Calibration 2

Calibration flights during 4-8 November 2007 at Hwange Main Camp airstrip

Run no.	Left observer: Godfrey Mtare			Right observer: Colin Zhuwau			Combined strip width (m) at flying height	Flying height agl (ft)	Combined strip width (m) when flying at 300 ft
	Outer marker	Inner marker	Strip width (m)	Outer marker	Inner marker	Strip width (m)			
1	24	9	160	24	7	180	340	300	340
2	28	12	170	22	7	160	330	290	341
3	25	8	180	24	9	160	340	320	319
4	23	8	160	17	5	130	290	250	348
5	29	13	170	14	3	120	290	250	348
6	24	9	160	23	8	160	320	280	343
7	29	13	170	25	8	180	350	280	375
8	26	11	160	-	-		-	310	
9	28	11	180	21	9	130	310	300	310
10	30	11	200	19	5	150	350	290	362
11	26	10	170	-	-		-	300	
12	25	9	170	20	6	150	320	300	320
13	27	10	180	16	2	150	330	260	381
14	19	8	120	17	2	160	280	270	311
15	30	13	180	21	13	90	270	350	231

Run no.	Left observer: Godfrey Mtare			Right observer: Colin Zhuwau			Combined strip width (m) at flying height	Flying height agl (ft)	Combined strip width (m) when flying at 300 ft
	Outer marker	Inner marker	Strip width (m)	Outer marker	Inner marker	Strip width (m)			
16	25	8	180	19	5	150	330	320	309
17	30	12	190	20	4	170	360	310	348
18	23	9	150	22	7	160	310	310	300
19	30	12	190	15	2	140	330	360	275
20	25	10	160	15	3	130	290	240	363
21	24	9	160	20	5	160	320	290	331
22	22	6	170	15	0	160	330	240	413
23	26	11	160	22	7	160	320	320	300
24	24	10	150	18	4	150	300	270	333
25	30	12	190	28	6	230	420	350	360
26	25	10	160	25	6	200	360	320	338
27	28	12	170	22	9	140	310	320	291
28	20	5	160	20	7	140	300	260	346
29	30	14	170	22	6	170	340	310	329
30	24	9	160	21	10	120	280	310	271
31	30	12	190	25	8	180	370	350	317
32	29	12	180	20	7	140	320	320	300
33	22	4	190	30	13	180	370	350	317
34	28	13	160	19	6	140	300	280	321
35	20	4	170	24	11	140	310	280	332
36	28	11	180	19	10	100	280	310	271
37	26	9	180	25	11	150	330	320	309
38	27	10	180	22	8	150	330	310	319
39	22	5	180	20	6	150	330	280	354
40	24	5	200	18	7	120	320	260	369
Mean combined strip width (in meters) when flying at 300 feet agl =								328	
Standard error of mean combined strip width as a percentage of the mean								1.7	

Appendix 2. Survey flight summary

Date	Time take off	Time land	Flight time (hours)	Duty
26-Oct-07	11:45	13:45	2.00	Positioning, Harare to Main Camp
27-Oct-07	7:07	8:00	0.88	Calibration
27-Oct-07	8:55	11:50	2.92	Stratum Kazungula
27-Oct-07	15:07	17:20	2.22	Stratum Zambezi NP + calibration
28-Oct-07	6:09	8:56	2.78	Stratum Panda Masuie
28-Oct-07	9:56	12:21	2.42	Stratum Kazuma
29-Oct-07	6:17	8:15	1.97	Stratum Matetsi
29-Oct-07	10:12	11:50	1.63	Stratum Rosslyn + calibration
29-Oct-07	14:56	17:22	2.43	Stratum Zanguja + calibration
30-Oct-07	6:12	8:21	2.15	Stratum Robins Camp + calibration
30-Oct-07	9:01	10:53	1.87	Stratum Robins Camp continued
30-Oct-07	14:26	17:03	2.62	Stratum Mtoa + calibration
31-Oct-07	6:09	8:10	2.02	Stratum Sinamatella
31-Oct-07	8:46	10:15	1.48	Stratum Sinamatella + calibration
31-Oct-07	14:35	16:12	1.62	Stratum Sinamatella + calibration
01-Nov-07	6:22	9:29	3.12	Stratum Shapi
01-Nov-07	11:49	14:00	2.18	Positioning, Main Camp to Harare
04-Nov-07	12:39	14:46	2.12	Positioning, Harare to Main Camp
04-Nov-07	15:13	18:00	2.78	Stratum Main Camp + calibration
05-Nov-07	6:10	6:33	0.38	Calibration
05-Nov-07	7:48	10:16	2.47	Stratum Dandari
05-Nov-07	10:36	12:28	1.87	Stratum Dandari continued
05-Nov-07	15:18	17:09	1.85	Stratum Main Camp continued + calibration
06-Nov-07	6:09	9:50	3.68	Stratum Shakwanki + calibration
06-Nov-07	15:00	17:00	2.00	Stratum Sikumi Forest + calibration
07-Nov-07	6:08	8:28	2.33	Stratum Ngamo
07-Nov-07	9:00	11:16	2.27	Stratum Ngamo continued
07-Nov-07	15:00	16:51	1.85	Stratum Central B + calibration
08-Nov-07	6:06	10:36	4.50	Stratum Dzivanini + calibration
08-Nov-07	15:00	16:45	1.75	Stratum Ngamo Forest
09-Nov-07	6:10	8:06	1.93	Stratum Central A
09-Nov-07	8:55	10:07	1.20	Stratum Tsholotsho North
09-Nov-07	15:07	17:30	2.38	Stratum Tsholotsho East
10-Nov-07	6:15	8:40	2.42	Stratum Maitengwe
10-Nov-07	10:41	12:44	2.05	Positioning, Main Camp to Harare
Total		76.13		

Appendix 3. Transect start and end points, and lengths

Degrees and decimal minutes; datum WGS84

Kazungula

Number of transects : 16
Transect Bearing : 0.00 Degrees
Transect Spacing : 2.30 km

Transect # : 1A

Start Lat : S 17 : 55.209 Start Lon : E 25 : 14.500
Finish Lat : S 17 : 54.061 Finish Lon : E 25 : 14.500
Length : 2.13 km

Transect # : 1B

Start Lat : S 17 : 53.654 Start Lon : E 25 : 14.500
Finish Lat : S 17 : 51.904 Finish Lon : E 25 : 14.500
Length : 3.24 km

Transect # : 2

Start Lat : S 17 : 49.070 Start Lon : E 25 : 15.803
Finish Lat : S 17 : 56.784 Finish Lon : E 25 : 15.803
Length : 14.28 km

Transect # : 3

Start Lat : S 17 : 56.798 Start Lon : E 25 : 17.107
Finish Lat : S 17 : 48.265 Finish Lon : E 25 : 17.107
Length : 15.80 km

Transect # : 4

Start Lat : S 17 : 49.146 Start Lon : E 25 : 18.411
Finish Lat : S 17 : 57.365 Finish Lon : E 25 : 18.411
Length : 15.22 km

Transect # : 5

Start Lat : S 17 : 57.907 Start Lon : E 25 : 19.714
Finish Lat : S 17 : 49.869 Finish Lon : E 25 : 19.714
Length : 14.89 km

Transect # : 6

Start Lat : S 17 : 50.221 Start Lon : E 25 : 21.018
Finish Lat : S 17 : 57.953 Finish Lon : E 25 : 21.018
Length : 14.32 km

Transect # : 7

Start Lat : S 17 : 58.034 Start Lon : E 25 : 22.322
Finish Lat : S 17 : 50.004 Finish Lon : E 25 : 22.322
Length : 14.87 km

Transect # : 8

Start Lat : S 17 : 50.925 Start Lon : E 25 : 23.626
Finish Lat : S 17 : 58.163 Finish Lon : E 25 : 23.626
Length : 13.40 km

Transect # : 9

Start Lat : S 17 : 58.572 Start Lon : E 25 : 24.929
Finish Lat : S 17 : 50.739 Finish Lon : E 25 : 24.929
Length : 14.50 km

Transect # : 10

Start Lat : S 17 : 50.939 Start Lon : E 25 : 26.233
Finish Lat : S 17 : 59.295 Finish Lon : E 25 : 26.233
Length : 15.47 km

Transect # : 11

Start Lat : S 17 : 58.765 Start Lon : E 25 : 27.537
Finish Lat : S 17 : 50.565 Finish Lon : E 25 : 27.537
Length : 15.19 km

Transect # : 12

Start Lat : S 17 : 50.938 Start Lon : E 25 : 28.840
Finish Lat : S 17 : 57.889 Finish Lon : E 25 : 28.840
Length : 12.87 km

Transect # : 13

Start Lat : S 17 : 57.846 Start Lon : E 25 : 30.144
Finish Lat : S 17 : 51.635 Finish Lon : E 25 : 30.144
Length : 11.50 km

Transect # : 14

Start Lat : S 17 : 52.283 Start Lon : E 25 : 31.448
Finish Lat : S 17 : 57.664 Finish Lon : E 25 : 31.448
Length : 9.97 km

Transect # : 15

Start Lat : S 17 : 57.352 Start Lon : E 25 : 32.752
Finish Lat : S 17 : 54.500 Finish Lon : E 25 : 32.752
Length : 5.28 km

Transect # : 16¹

Start Lat : S 17 : 56.716 Start Lon : E 25 : 34.055
Finish Lat : S 17 : 57.040 Finish Lon : E 25 : 34.055
Length : 0.60 km

¹ Not flown

Zambezi NP

Number of transects : 7
Transect Bearing : 0.00 Degrees
Transect Spacing : 4.20 km

Transect # : 1
Start Lat : S 17 : 55.513 Start Lon : E 25 : 33.348
Finish Lat : S 17 : 50.541 Finish Lon : E 25 : 33.348
Length : 9.21 km

Transect # : 2
Start Lat : S 17 : 50.793 Start Lon : E 25 : 35.729
Finish Lat : S 17 : 59.477 Finish Lon : E 25 : 35.729
Length : 16.08 km

Transect # : 3
Start Lat : S 18 : 2.401 Start Lon : E 25 : 38.111
Finish Lat : S 17 : 50.336 Finish Lon : E 25 : 38.111
Length : 22.34 km

Transect # : 4
Start Lat : S 17 : 49.084 Start Lon : E 25 : 40.492
Finish Lat : S 18 : 2.402 Finish Lon : E 25 : 40.492
Length : 24.66 km

Transect # : 5
Start Lat : S 18 : 2.404 Start Lon : E 25 : 42.873
Finish Lat : S 17 : 50.634 Finish Lon : E 25 : 42.873
Length : 21.80 km

Transect # : 6
Start Lat : S 17 : 51.111 Start Lon : E 25 : 45.255
Finish Lat : S 18 : 1.765 Finish Lon : E 25 : 45.255
Length : 19.73 km

Transect # : 7
Start Lat : S 17 : 59.217 Start Lon : E 25 : 47.636
Finish Lat : S 17 : 52.719 Finish Lon : E 25 : 47.636
Length : 12.03 km

Panda Masuie

Number of transects : 11
Transect Bearing : 0.00 Degrees
Transect Spacing : 4.70 km

Transect # : 1
Start Lat : S 18 : 3.426 Start Lon : E 25 : 18.544
Finish Lat : S 17 : 57.431 Finish Lon : E 25 : 18.544
Length : 11.10 km

Transect # : 2
Start Lat : S 17 : 57.959 Start Lon : E 25 : 21.210
Finish Lat : S 18 : 5.404 Finish Lon : E 25 : 21.210
Length : 13.79 km

Transect # : 3
Start Lat : S 18 : 7.706 Start Lon : E 25 : 23.875
Finish Lat : S 17 : 58.187 Finish Lon : E 25 : 23.875
Length : 17.63 km

Transect # : 4
Start Lat : S 17 : 59.502 Start Lon : E 25 : 26.541
Finish Lat : S 18 : 11.829 Finish Lon : E 25 : 26.541
Length : 22.83 km

Transect # : 5
Start Lat : S 18 : 14.100 Start Lon : E 25 : 29.206
Finish Lat : S 17 : 57.877 Finish Lon : E 25 : 29.206
Length : 30.04 km

Transect # : 6
Start Lat : S 17 : 57.563 Start Lon : E 25 : 31.872
Finish Lat : S 18 : 13.761 Finish Lon : E 25 : 31.872
Length : 30.00 km

Transect # : 7
Start Lat : S 18 : 13.279 Start Lon : E 25 : 34.537
Finish Lat : S 17 : 57.519 Finish Lon : E 25 : 34.537
Length : 29.19 km

Transect # : 8
Start Lat : S 18 : 1.910 Start Lon : E 25 : 37.202
Finish Lat : S 18 : 12.797 Finish Lon : E 25 : 37.202
Length : 20.16 km

Transect # : 9
Start Lat : S 18 : 12.315 Start Lon : E 25 : 39.868
Finish Lat : S 18 : 2.400 Finish Lon : E 25 : 39.868
Length : 18.36 km

Transect # : 10A
Start Lat : S 18 : 2.400 Start Lon : E 25 : 42.533
Finish Lat : S 18 : 4.637 Finish Lon : E 25 : 42.533
Length : 4.14 km

Transect # : 10B
Start Lat : S 18 : 10.061 Start Lon : E 25 : 42.533
Finish Lat : S 18 : 11.520 Finish Lon : E 25 : 42.533
Length : 2.70 km

Transect # : 11
Start Lat : S 18 : 10.543 Start Lon : E 25 : 45.199
Finish Lat : S 18 : 9.685 Finish Lon : E 25 : 45.199
Length : 1.59 km

Kazuma

Number of transects : 7
Transect Bearing : 0.00 Degrees
Transect Spacing : 4.70 km

Transect # : 1
Start Lat : S 18 : 16.357 Start Lon : E 25 : 28.540
Finish Lat : S 18 : 14.100 Finish Lon : E 25 : 28.540
Length : 4.18 km

Transect # : 2
Start Lat : S 18 : 13.881 Start Lon : E 25 : 31.211
Finish Lat : S 18 : 22.800 Finish Lon : E 25 : 31.211
Length : 16.52 km

Transect # : 3
Start Lat : S 18 : 25.595 Start Lon : E 25 : 33.882
Finish Lat : S 18 : 13.398 Finish Lon : E 25 : 33.882
Length : 22.59 km

Transect # : 4
Start Lat : S 18 : 12.914 Start Lon : E 25 : 36.553
Finish Lat : S 18 : 27.774 Finish Lon : E 25 : 36.553
Length : 27.52 km

Transect # : 5
Start Lat : S 18 : 26.071 Start Lon : E 25 : 39.224
Finish Lat : S 18 : 12.431 Finish Lon : E 25 : 39.224
Length : 25.26 km

Transect # : 6
Start Lat : S 18 : 14.289 Start Lon : E 25 : 41.895
Finish Lat : S 18 : 23.997 Finish Lon : E 25 : 41.895
Length : 17.98 km

Transect # : 7
Start Lat : S 18 : 21.600 Start Lon : E 25 : 44.566
Finish Lat : S 18 : 17.069 Finish Lon : E 25 : 44.566
Length : 8.39 km

Matetsi

Number of transects : 6
Transect Bearing : -50.00 Degrees
Transect Spacing : 6.90 km

Transect # : 1
Start Lat : S 18 : 31.695 Start Lon : E 25 : 41.646
Finish Lat : S 18 : 27.721 Finish Lon : E 25 : 36.663
Length : 11.45 km

Transect # : 2
Start Lat : S 18 : 25.493 Start Lon : E 25 : 39.968
Finish Lat : S 18 : 29.954 Finish Lon : E 25 : 45.561
Length : 12.85 km

Transect # : 3
Start Lat : S 18 : 28.028 Start Lon : E 25 : 49.246
Finish Lat : S 18 : 22.683 Finish Lon : E 25 : 42.544
Length : 15.40 km

Transect # : 4
Start Lat : S 18 : 19.821 Start Lon : E 25 : 45.054
Finish Lat : S 18 : 26.858 Finish Lon : E 25 : 53.877
Length : 20.27 km

Transect # : 5
Start Lat : S 18 : 23.022 Start Lon : E 25 : 55.167
Finish Lat : S 18 : 11.963 Finish Lon : E 25 : 41.300
Length : 31.86 km

Transect # : 6
Start Lat : S 18 : 10.356 Start Lon : E 25 : 45.383
Finish Lat : S 18 : 16.816 Finish Lon : E 25 : 53.484
Length : 18.61 km

Rosslyn

Number of transects : 5
Transect Bearing : 90.00 Degrees
Transect Spacing : 4.60 km

Transect # : 1
Start Lat : S 18 : 27.517 Start Lon : E 25 : 53.630
Finish Lat : S 18 : 27.517 Finish Lon : E 25 : 52.887
Length : 1.31 km

Transect # : 2
Start Lat : S 18 : 30.001 Start Lon : E 25 : 45.484
Finish Lat : S 18 : 30.001 Finish Lon : E 25 : 55.094
Length : 16.89 km

Transect # : 3
Start Lat : S 18 : 32.485 Start Lon : E 25 : 54.597

Finish Lat : S 18 : 32.485 Finish Lon : E 25 : 40.348
Length : 25.04 km

Transect # : 4
Start Lat : S 18 : 34.969 Start Lon : E 25 : 42.432
Finish Lat : S 18 : 34.969 Finish Lon : E 25 : 54.206
Length : 20.69 km

Transect # : 5
Start Lat : S 18 : 37.453 Start Lon : E 25 : 52.091
Finish Lat : S 18 : 37.453 Finish Lon : E 25 : 46.619
Length : 9.61 km

Zanguja

Number of transects : 8

Transect Bearing : 29.00 Degrees

Transect Spacing : 5.10 km

Transect # : 1

Start Lat : S 18 : 20.536 Start Lon : E 25 : 54.451
Finish Lat : S 18 : 20.352 Finish Lon : E 25 : 54.558
Length : 0.39 km

Transect # : 2A

Start Lat : S 18 : 18.061 Start Lon : E 25 : 59.210
Finish Lat : S 18 : 25.224 Finish Lon : E 25 : 55.030
Length : 15.17 km

Transect # : 2B

Start Lat : S 18 : 26.775 Start Lon : E 25 : 54.125
Finish Lat : S 18 : 27.574 Finish Lon : E 25 : 53.659
Length : 1.69 km

Transect # : 3

Start Lat : S 18 : 30.369 Start Lon : E 25 : 55.343
Finish Lat : S 18 : 17.712 Finish Lon : E 26 : 2.728
Length : 26.80 km

Transect # : 4

Start Lat : S 18 : 17.988 Start Lon : E 26 : 5.882
Finish Lat : S 18 : 34.827 Finish Lon : E 25 : 56.056
Length : 35.65 km

Transect # : 5

Start Lat : S 18 : 32.468 Start Lon : E 26 : 0.747
Finish Lat : S 18 : 17.299 Finish Lon : E 26 : 9.599
Length : 32.12 km

Transect # : 6

Start Lat : S 18 : 19.537 Start Lon : E 26 : 11.608
Finish Lat : S 18 : 31.377 Finish Lon : E 26 : 4.699
Length : 25.07 km

Transect # : 7

Start Lat : S 18 : 30.308 Start Lon : E 26 : 8.637
Finish Lat : S 18 : 21.647 Finish Lon : E 26 : 13.691
Length : 18.34 km

Transect # : 8

Start Lat : S 18 : 22.524 Start Lon : E 26 : 16.494
Finish Lat : S 18 : 25.047 Finish Lon : E 26 : 15.021
Length : 5.34 km

Robins Camp

Number of transects : 14

Transect Bearing : 90.00 Degrees

Transect Spacing : 2.60 km

Transect # : 1

Start Lat : S 18 : 30.287 Start Lon : E 26 : 10.270
Finish Lat : S 18 : 30.287 Finish Lon : E 26 : 8.717
Length : 2.73 km

Length : 35.75 km

Transect # : 2

Start Lat : S 18 : 31.691 Start Lon : E 26 : 3.563
Finish Lat : S 18 : 31.691 Finish Lon : E 26 : 10.091
Length : 11.47 km

Transect # : 7

Start Lat : S 18 : 38.711 Start Lon : E 26 : 12.254
Finish Lat : S 18 : 38.711 Finish Lon : E 25 : 49.292
Length : 40.35 km

Transect # : 3

Start Lat : S 18 : 33.094 Start Lon : E 26 : 10.250
Finish Lat : S 18 : 33.094 Finish Lon : E 25 : 59.477
Length : 18.93 km

Transect # : 8

Start Lat : S 18 : 40.115 Start Lon : E 25 : 47.701
Finish Lat : S 18 : 40.115 Finish Lon : E 26 : 12.336
Length : 43.29 km

Transect # : 4

Start Lat : S 18 : 34.499 Start Lon : E 25 : 56.980
Finish Lat : S 18 : 34.499 Finish Lon : E 26 : 11.678
Length : 25.83 km

Transect # : 9

Start Lat : S 18 : 41.519 Start Lon : E 26 : 12.611
Finish Lat : S 18 : 41.519 Finish Lon : E 25 : 47.654
Length : 43.85 km

Transect # : 5

Start Lat : S 18 : 35.903 Start Lon : E 26 : 12.000
Finish Lat : S 18 : 35.903 Finish Lon : E 25 : 52.850
Length : 33.65 km

Transect # : 10

Start Lat : S 18 : 42.923 Start Lon : E 25 : 47.609
Finish Lat : S 18 : 42.923 Finish Lon : E 26 : 12.993
Length : 44.60 km

Transect # : 6

Start Lat : S 18 : 37.306 Start Lon : E 25 : 52.140
Finish Lat : S 18 : 37.306 Finish Lon : E 26 : 12.484
Length : 36.05 km

Transect # : 11

Start Lat : S 18 : 44.327 Start Lon : E 26 : 8.162
Finish Lat : S 18 : 44.327 Finish Lon : E 25 : 47.647
Length : 36.05 km

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Transect # : 12 Start Lat : S 18 : 45.731 Start Lon : E 25 : 47.903 Finish Lat : S 18 : 45.731 Finish Lon : E 26 : 6.793 Length : 33.19 km	Transect # : 14A Start Lat : S 18 : 48.539 Start Lon : E 25 : 53.056 Finish Lat : S 18 : 48.539 Finish Lon : E 25 : 54.151 Length : 1.92 km
Transect # : 13 Start Lat : S 18 : 47.135 Start Lon : E 26 : 1.652 Finish Lat : S 18 : 47.135 Finish Lon : E 25 : 48.249 Length : 23.55 km	Transect # : 14B Start Lat : S 18 : 48.539 Start Lon : E 25 : 54.458 Finish Lat : S 18 : 48.539 Finish Lon : E 25 : 56.051 Length : 2.80 km
Sinamatella	
Number of transects : 20	
Transect Bearing : 0.00 Degrees	
Transect Spacing : 2.90 km	
Transect # : 1 Start Lat : S 18 : 33.590 Start Lon : E 26 : 10.559 Finish Lat : S 18 : 29.197 Finish Lon : E 26 : 10.559 Length : 8.14 km	Transect # : 9 Start Lat : S 18 : 46.864 Start Lon : E 26 : 23.753 Finish Lat : S 18 : 28.580 Finish Lon : E 26 : 23.753 Length : 33.86 km
Transect # : 2A Start Lat : S 18 : 27.383 Start Lon : E 26 : 12.208 Finish Lat : S 18 : 37.015 Finish Lon : E 26 : 12.208 Length : 17.84 km	Transect # : 10 Start Lat : S 18 : 28.211 Start Lon : E 26 : 25.402 Finish Lat : S 18 : 45.949 Finish Lon : E 26 : 25.402 Length : 32.85 km
Transect # : 2B Start Lat : S 18 : 38.750 Start Lon : E 26 : 12.208 Finish Lat : S 18 : 39.661 Finish Lon : E 26 : 12.208 Length : 1.69 km	Transect # : 11 Start Lat : S 18 : 45.731 Start Lon : E 26 : 27.051 Finish Lat : S 18 : 27.579 Finish Lon : E 26 : 27.051 Length : 33.61 km
Transect # : 3 Start Lat : S 18 : 42.369 Start Lon : E 26 : 13.857 Finish Lat : S 18 : 26.359 Finish Lon : E 26 : 13.857 Length : 29.65 km	Transect # : 12 Start Lat : S 18 : 27.000 Start Lon : E 26 : 28.701 Finish Lat : S 18 : 44.373 Finish Lon : E 26 : 28.701 Length : 32.17 km
Transect # : 4 Start Lat : S 18 : 24.988 Start Lon : E 26 : 15.506 Finish Lat : S 18 : 41.796 Finish Lon : E 26 : 15.506 Length : 31.13 km	Transect # : 13 Start Lat : S 18 : 43.366 Start Lon : E 26 : 30.350 Finish Lat : S 18 : 27.075 Finish Lon : E 26 : 30.350 Length : 30.17 km
Transect # : 5A Start Lat : S 18 : 46.441 Start Lon : E 26 : 17.156 Finish Lat : S 18 : 42.600 Finish Lon : E 26 : 17.156 Length : 7.11 km	Transect # : 14 Start Lat : S 18 : 28.178 Start Lon : E 26 : 31.999 Finish Lat : S 18 : 43.200 Finish Lon : E 26 : 31.999 Length : 27.82 km
Transect # : 5B Start Lat : S 18 : 42.070 Start Lon : E 26 : 17.156 Finish Lat : S 18 : 23.382 Finish Lon : E 26 : 17.156 Length : 34.61 km	Transect # : 15 Start Lat : S 18 : 42.900 Start Lon : E 26 : 33.648 Finish Lat : S 18 : 27.770 Finish Lon : E 26 : 33.648 Length : 28.02 km
Transect # : 6 Start Lat : S 18 : 25.875 Start Lon : E 26 : 18.805 Finish Lat : S 18 : 47.400 Finish Lon : E 26 : 18.805 Length : 39.86 km	Transect # : 16 Start Lat : S 18 : 28.578 Start Lon : E 26 : 35.298 Finish Lat : S 18 : 41.655 Finish Lon : E 26 : 35.298 Length : 24.22 km
Transect # : 7 Start Lat : S 18 : 48.109 Start Lon : E 26 : 20.454 Finish Lat : S 18 : 27.933 Finish Lon : E 26 : 20.454 Length : 37.36 km	Transect # : 17 Start Lat : S 18 : 39.475 Start Lon : E 26 : 36.947 Finish Lat : S 18 : 29.627 Finish Lon : E 26 : 36.947 Length : 18.24 km
Transect # : 8 Start Lat : S 18 : 28.828 Start Lon : E 26 : 22.104 Finish Lat : S 18 : 48.159 Finish Lon : E 26 : 22.104 Length : 35.80 km	Transect # : 18 Start Lat : S 18 : 30.700 Start Lon : E 26 : 38.596 Finish Lat : S 18 : 36.548 Finish Lon : E 26 : 38.596 Length : 10.83 km

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Transect # : 19
Start Lat : S 18 : 34.298 Start Lon : E 26 : 40.246
Finish Lat : S 18 : 30.035 Finish Lon : E 26 : 40.246
Length : 7.89 km

Transect # : 20
Start Lat : S 18 : 30.312 Start Lon : E 26 : 41.895
Finish Lat : S 18 : 31.042 Finish Lon : E 26 : 41.895
Length : 1.35 km

Mtoa

Number of transects : 18
Transect Bearing : 0.00 Degrees
Transect Spacing : 3.00 km

Transect # : 1
Start Lat : S 18 : 50.400 Start Lon : E 26 : 22.169
Finish Lat : S 18 : 48.132 Finish Lon : E 26 : 22.169
Length : 4.20 km

Transect # : 10
Start Lat : S 18 : 38.838 Start Lon : E 26 : 37.534
Finish Lat : S 18 : 51.300 Finish Lon : E 26 : 37.534
Length : 23.08 km

Transect # : 2
Start Lat : S 18 : 46.683 Start Lon : E 26 : 23.876
Finish Lat : S 18 : 50.937 Finish Lon : E 26 : 23.876
Length : 7.88 km

Transect # : 11
Start Lat : S 18 : 48.296 Start Lon : E 26 : 39.241
Finish Lat : S 18 : 36.009 Finish Lon : E 26 : 39.241
Length : 22.75 km

Transect # : 3
Start Lat : S 18 : 51.624 Start Lon : E 26 : 25.583
Finish Lat : S 18 : 45.935 Finish Lon : E 26 : 25.583
Length : 10.53 km

Transect # : 12
Start Lat : S 18 : 32.422 Start Lon : E 26 : 40.949
Finish Lat : S 18 : 45.778 Finish Lon : E 26 : 40.949
Length : 24.73 km

Transect # : 4
Start Lat : S 18 : 45.483 Start Lon : E 26 : 27.290
Finish Lat : S 18 : 51.985 Finish Lon : E 26 : 27.290
Length : 12.04 km

Transect # : 13
Start Lat : S 18 : 44.336 Start Lon : E 26 : 42.656
Finish Lat : S 18 : 31.226 Finish Lon : E 26 : 42.656
Length : 24.28 km

Transect # : 5
Start Lat : S 18 : 52.244 Start Lon : E 26 : 28.998
Finish Lat : S 18 : 44.136 Finish Lon : E 26 : 28.998
Length : 15.01 km

Transect # : 14
Start Lat : S 18 : 31.871 Start Lon : E 26 : 44.363
Finish Lat : S 18 : 43.611 Finish Lon : E 26 : 44.363
Length : 21.74 km

Transect # : 6
Start Lat : S 18 : 43.425 Start Lon : E 26 : 30.705
Finish Lat : S 18 : 52.132 Finish Lon : E 26 : 30.705
Length : 16.12 km

Transect # : 15
Start Lat : S 18 : 42.155 Start Lon : E 26 : 46.070
Finish Lat : S 18 : 32.429 Finish Lon : E 26 : 46.070
Length : 18.01 km

Transect # : 7
Start Lat : S 18 : 51.420 Start Lon : E 26 : 32.412
Finish Lat : S 18 : 43.192 Finish Lon : E 26 : 32.412
Length : 15.24 km

Transect # : 16
Start Lat : S 18 : 33.251 Start Lon : E 26 : 47.778
Finish Lat : S 18 : 40.803 Finish Lon : E 26 : 47.778
Length : 13.98 km

Transect # : 8
Start Lat : S 18 : 42.606 Start Lon : E 26 : 34.120
Finish Lat : S 18 : 51.551 Finish Lon : E 26 : 34.120
Length : 16.56 km

Transect # : 17
Start Lat : S 18 : 40.445 Start Lon : E 26 : 49.485
Finish Lat : S 18 : 35.655 Finish Lon : E 26 : 49.485
Length : 8.87 km

Transect # : 9
Start Lat : S 18 : 51.367 Start Lon : E 26 : 35.827
Finish Lat : S 18 : 41.297 Finish Lon : E 26 : 35.827
Length : 18.65 km

Transect # : 18
Start Lat : S 18 : 37.182 Start Lon : E 26 : 51.192
Finish Lat : S 18 : 37.277 Finish Lon : E 26 : 51.192
Length : 0.18 km

Shapi
Number of transects : 21
Transect Bearing : 0.00 Degrees
Transect Spacing : 2.80 km

Transect # : 1A
Start Lat : S 18 : 59.924 Start Lon : E 26 : 18.728

Finish Lat : S 19 : 0.332 Finish Lon : E 26 : 18.728
Length : 0.76 km

Transect # : 1B

Start Lat : S 19 : 0.801 Start Lon : E 26 : 18.728
Finish Lat : S 19 : 1.492 Finish Lon : E 26 : 18.728
Length : 1.28 km

Transect # : 2

Start Lat : S 19 : 6.400 Start Lon : E 26 : 20.324
Finish Lat : S 18 : 58.839 Finish Lon : E 26 : 20.324
Length : 14.00 km

Transect # : 3

Start Lat : S 18 : 58.098 Start Lon : E 26 : 21.920
Finish Lat : S 19 : 8.144 Finish Lon : E 26 : 21.920
Length : 18.61 km

Transect # : 4

Start Lat : S 19 : 6.879 Start Lon : E 26 : 23.516
Finish Lat : S 18 : 55.778 Finish Lon : E 26 : 23.516
Length : 20.56 km

Transect # : 5

Start Lat : S 18 : 54.830 Start Lon : E 26 : 25.112
Finish Lat : S 19 : 6.545 Finish Lon : E 26 : 25.112
Length : 21.69 km

Transect # : 6

Start Lat : S 19 : 5.263 Start Lon : E 26 : 26.708
Finish Lat : S 18 : 53.891 Finish Lon : E 26 : 26.708
Length : 21.06 km

Transect # : 7

Start Lat : S 18 : 53.279 Start Lon : E 26 : 28.304
Finish Lat : S 19 : 3.866 Finish Lon : E 26 : 28.304
Length : 19.61 km

Transect # : 8

Start Lat : S 19 : 3.428 Start Lon : E 26 : 29.900
Finish Lat : S 18 : 52.271 Finish Lon : E 26 : 29.900
Length : 20.66 km

Transect # : 9

Start Lat : S 18 : 51.995 Start Lon : E 26 : 31.496
Finish Lat : S 19 : 2.858 Finish Lon : E 26 : 31.496
Length : 20.12 km

Transect # : 10

Start Lat : S 19 : 2.426 Start Lon : E 26 : 33.092
Finish Lat : S 18 : 51.522 Finish Lon : E 26 : 33.092
Length : 20.19 km

Transect # : 11

Start Lat : S 18 : 51.517 Start Lon : E 26 : 34.688
Finish Lat : S 19 : 1.294 Finish Lon : E 26 : 34.688
Length : 18.10 km

Transect # : 12

Start Lat : S 19 : 0.134 Start Lon : E 26 : 36.283
Finish Lat : S 18 : 51.181 Finish Lon : E 26 : 36.283
Length : 16.58 km

Transect # : 13

Start Lat : S 18 : 51.300 Start Lon : E 26 : 37.879
Finish Lat : S 18 : 58.908 Finish Lon : E 26 : 37.879
Length : 14.09 km

Transect # : 14

Start Lat : S 18 : 58.451 Start Lon : E 26 : 39.475
Finish Lat : S 18 : 51.129 Finish Lon : E 26 : 39.475
Length : 13.56 km

Transect # : 15

Start Lat : S 18 : 50.425 Start Lon : E 26 : 41.071
Finish Lat : S 18 : 58.275 Finish Lon : E 26 : 41.071
Length : 14.54 km

Transect # : 16

Start Lat : S 18 : 58.414 Start Lon : E 26 : 42.667
Finish Lat : S 18 : 50.243 Finish Lon : E 26 : 42.667
Length : 15.13 km

Transect # : 17

Start Lat : S 18 : 49.540 Start Lon : E 26 : 44.263
Finish Lat : S 18 : 58.189 Finish Lon : E 26 : 44.263
Length : 16.02 km

Transect # : 18

Start Lat : S 18 : 57.900 Start Lon : E 26 : 45.859
Finish Lat : S 18 : 49.741 Finish Lon : E 26 : 45.859
Length : 15.11 km

Transect # : 19

Start Lat : S 18 : 49.650 Start Lon : E 26 : 47.455
Finish Lat : S 18 : 57.834 Finish Lon : E 26 : 47.455
Length : 15.16 km

Transect # : 20

Start Lat : S 18 : 57.786 Start Lon : E 26 : 49.051
Finish Lat : S 18 : 53.573 Finish Lon : E 26 : 49.051
Length : 7.80 km

Transect # : 21

Start Lat : S 18 : 56.133 Start Lon : E 26 : 50.647
Finish Lat : S 18 : 57.892 Finish Lon : E 26 : 50.647
Length : 3.26 km

Ngamo Forest

Number of transects : 5

Transect Bearing : 41.00 Degrees

Transect Spacing : 9.00 km

Transect # : 1

Start Lat : S 18 : 59.253 Start Lon : E 27 : 19.314
Finish Lat : S 18 : 47.203 Finish Lon : E 27 : 30.370
Length : 29.57 km

Transect # : 2

Start Lat : S 18 : 48.753 Start Lon : E 27 : 35.744
Finish Lat : S 19 : 2.330 Finish Lon : E 27 : 23.287
Length : 33.31 km

Transect # : 3
Start Lat : S 19 : 5.407 Start Lon : E 27 : 27.261
Finish Lat : S 18 : 52.451 Finish Lon : E 27 : 39.148
Length : 31.79 km

Transect # : 4
Start Lat : S 18 : 55.323 Start Lon : E 27 : 43.310
Finish Lat : S 19 : 5.850 Finish Lon : E 27 : 33.651
Length : 25.83 km

Shakwanki

Number of transects : 11
Transect Bearing : 90.00 Degrees
Transect Spacing : 6.30 km

Transect # : 1A
Start Lat : S 18 : 59.764 Start Lon : E 26 : 18.857
Finish Lat : S 18 : 59.764 Finish Lon : E 26 : 7.284
Length : 20.27 km

Transect # : 1B
Start Lat : S 18 : 59.764 Start Lon : E 26 : 4.288
Finish Lat : S 18 : 59.764 Finish Lon : E 26 : 3.100
Length : 2.08 km

Transect # : 2
Start Lat : S 19 : 3.166 Start Lon : E 25 : 58.787
Finish Lat : S 19 : 3.166 Finish Lon : E 26 : 19.560
Length : 36.39 km

Transect # : 3
Start Lat : S 19 : 6.569 Start Lon : E 26 : 20.375
Finish Lat : S 19 : 6.569 Finish Lon : E 25 : 58.088
Length : 39.04 km

Transect # : 4
Start Lat : S 19 : 9.971 Start Lon : E 26 : 0.663
Finish Lat : S 19 : 9.971 Finish Lon : E 26 : 21.992
Length : 37.36 km

Transect # : 5
Start Lat : S 19 : 13.373 Start Lon : E 26 : 24.072
Finish Lat : S 19 : 13.373 Finish Lon : E 26 : 2.722
Length : 37.40 km

Dzivanini
Number of transects : 14
Transect Bearing : 90.00 Degrees
Transect Spacing : 4.30 km

Transect # : 1
Start Lat : S 19 : 20.914 Start Lon : E 26 : 55.371
Finish Lat : S 19 : 20.914 Finish Lon : E 26 : 50.622
Length : 8.31 km

Transect # : 2
Start Lat : S 19 : 23.236 Start Lon : E 26 : 42.105
Finish Lat : S 19 : 23.236 Finish Lon : E 26 : 53.515
Length : 19.96 km

Transect # : 3
Start Lat : S 19 : 25.558 Start Lon : E 26 : 52.366
Finish Lat : S 19 : 25.558 Finish Lon : E 26 : 26.479
Length : 45.27 km

Transect # : 4
Start Lat : S 19 : 27.880 Start Lon : E 26 : 24.459
Finish Lat : S 19 : 27.880 Finish Lon : E 26 : 51.503
Length : 47.29 km

Transect # : 5
Start Lat : S 19 : 26.981 Start Lon : E 26 : 24.205
Finish Lat : S 19 : 26.981 Finish Lon : E 26 : 8.555
Length : 27.41 km

Transect # : 6
Start Lat : S 19 : 16.775 Start Lon : E 26 : 4.524
Finish Lat : S 19 : 16.775 Finish Lon : E 26 : 25.486
Length : 36.72 km

Transect # : 7
Start Lat : S 19 : 20.177 Start Lon : E 26 : 27.334
Finish Lat : S 19 : 20.177 Finish Lon : E 26 : 5.711
Length : 37.88 km

Transect # : 8
Start Lat : S 19 : 23.578 Start Lon : E 26 : 7.157
Finish Lat : S 19 : 23.578 Finish Lon : E 26 : 28.633
Length : 37.62 km

Transect # : 9
Start Lat : S 19 : 26.981 Start Lon : E 26 : 24.205
Finish Lat : S 19 : 26.981 Finish Lon : E 26 : 8.555
Length : 27.41 km

Transect # : 10
Start Lat : S 19 : 30.383 Start Lon : E 26 : 9.530
Finish Lat : S 19 : 30.383 Finish Lon : E 26 : 24.338
Length : 25.94 km

Transect # : 11
Start Lat : S 19 : 33.785 Start Lon : E 26 : 14.487
Finish Lat : S 19 : 33.785 Finish Lon : E 26 : 13.084
Length : 2.46 km

Transect # : 5

Start Lat : S 19 : 30.202 Start Lon : E 26 : 50.630
Finish Lat : S 19 : 30.202 Finish Lon : E 26 : 24.389
Length : 45.89 km

Transect # : 6

Start Lat : S 19 : 32.524 Start Lon : E 26 : 19.947
Finish Lat : S 19 : 32.524 Finish Lon : E 26 : 49.758
Length : 52.13 km

Transect # : 7A

Start Lat : S 19 : 34.846 Start Lon : E 26 : 48.886
Finish Lat : S 19 : 34.846 Finish Lon : E 26 : 18.948
Length : 52.36 km

Transect # : 7B

Start Lat : S 19 : 34.846 Start Lon : E 26 : 15.848
Finish Lat : S 19 : 34.846 Finish Lon : E 26 : 14.530
Length : 2.30 km

Transect # : 8

Start Lat : S 19 : 37.168 Start Lon : E 26 : 20.722
Finish Lat : S 19 : 37.168 Finish Lon : E 26 : 48.013
Length : 47.73 km

Transect # : 9

Start Lat : S 19 : 39.490 Start Lon : E 26 : 47.141
Finish Lat : S 19 : 39.490 Finish Lon : E 26 : 19.667
Length : 48.05 km

Transect # : 10

Start Lat : S 19 : 41.812 Start Lon : E 26 : 24.420
Finish Lat : S 19 : 41.812 Finish Lon : E 26 : 46.269
Length : 38.21 km

Transect # : 11

Start Lat : S 19 : 44.134 Start Lon : E 26 : 45.396
Finish Lat : S 19 : 44.134 Finish Lon : E 26 : 25.395
Length : 34.98 km

Transect # : 12

Start Lat : S 19 : 46.456 Start Lon : E 26 : 32.234
Finish Lat : S 19 : 46.456 Finish Lon : E 26 : 44.524
Length : 21.49 km

Transect # : 13

Start Lat : S 19 : 48.778 Start Lon : E 26 : 43.652
Finish Lat : S 19 : 48.778 Finish Lon : E 26 : 35.077
Length : 15.00 km

Transect # : 14

Start Lat : S 19 : 51.101 Start Lon : E 26 : 36.060
Finish Lat : S 19 : 51.101 Finish Lon : E 26 : 42.779
Length : 11.75 km

Tsholotsho East

Number of transects : 9

Transect Bearing : 90.00 Degrees

Transect Spacing : 6.90 km

Transect # : 1

Start Lat : S 19 : 22.405 Start Lon : E 26 : 54.133
Finish Lat : S 19 : 22.405 Finish Lon : E 26 : 54.707
Length : 1.00 km

Transect # : 6

Start Lat : S 19 : 41.036 Start Lon : E 26 : 57.859
Finish Lat : S 19 : 41.036 Finish Lon : E 26 : 46.561
Length : 19.74 km

Transect # : 2

Start Lat : S 19 : 26.132 Start Lon : E 27 : 0.259
Finish Lat : S 19 : 26.132 Finish Lon : E 26 : 52.119
Length : 14.22 km

Transect # : 7

Start Lat : S 19 : 44.762 Start Lon : E 26 : 45.161
Finish Lat : S 19 : 44.762 Finish Lon : E 26 : 58.305
Length : 22.97 km

Transect # : 3

Start Lat : S 19 : 29.858 Start Lon : E 26 : 50.760
Finish Lat : S 19 : 29.858 Finish Lon : E 27 : 0.231
Length : 16.55 km

Transect # : 8

Start Lat : S 19 : 48.487 Start Lon : E 26 : 59.871
Finish Lat : S 19 : 48.487 Finish Lon : E 26 : 43.761
Length : 28.15 km

Transect # : 4

Start Lat : S 19 : 33.583 Start Lon : E 26 : 57.335
Finish Lat : S 19 : 33.583 Finish Lon : E 26 : 49.360
Length : 13.94 km

Transect # : 9

Start Lat : S 19 : 52.214 Start Lon : E 26 : 42.361
Finish Lat : S 19 : 52.214 Finish Lon : E 26 : 43.479
Length : 1.95 km

Transect # : 5

Start Lat : S 19 : 37.309 Start Lon : E 26 : 47.960
Finish Lat : S 19 : 37.309 Finish Lon : E 26 : 57.579
Length : 16.81 km

Maitengwe

Number of transects : 6
Transect Bearing : 0.00 Degrees
Transect Spacing : 9.50 km

Transect # : 1
Start Lat : S 19 : 42.975 Start Lon : E 27 : 9.303
Finish Lat : S 20 : 2.700 Finish Lon : E 27 : 9.303
Length : 36.53 km

Transect # : 2
Start Lat : S 20 : 1.256 Start Lon : E 27 : 3.859
Finish Lat : S 19 : 42.248 Finish Lon : E 27 : 3.859
Length : 35.20 km

Transect # : 3A
Start Lat : S 19 : 40.372 Start Lon : E 26 : 58.414
Finish Lat : S 19 : 45.254 Finish Lon : E 26 : 58.414
Length : 9.04 km

Transect # : 3B
Start Lat : S 19 : 48.704 Start Lon : E 26 : 58.414
Finish Lat : S 20 : 0.640 Finish Lon : E 26 : 58.414
Length : 22.11 km

Transect # : 4
Start Lat : S 19 : 58.409 Start Lon : E 26 : 52.969
Finish Lat : S 19 : 49.106 Finish Lon : E 26 : 52.969
Length : 17.23 km

Transect # : 5
Start Lat : S 19 : 50.938 Start Lon : E 26 : 47.525
Finish Lat : S 19 : 56.720 Finish Lon : E 26 : 47.525
Length : 10.71 km

Transect # : 6
Start Lat : S 19 : 53.844 Start Lon : E 26 : 42.080
Finish Lat : S 19 : 53.123 Finish Lon : E 26 : 42.080
Length : 1.33 km

Tsholotsho Far North

Number of transects : 8
Transect Bearing : 0.00 Degrees
Transect Spacing : 10.00 km

Transect # : 1
Start Lat : S 19 : 23.034 Start Lon : E 26 : 55.677
Finish Lat : S 19 : 20.250 Finish Lon : E 26 : 55.677
Length : 5.15 km

Transect # : 2
Start Lat : S 19 : 19.725 Start Lon : E 27 : 1.384
Finish Lat : S 19 : 22.488 Finish Lon : E 27 : 1.384
Length : 5.10 km

Transect # : 3
Start Lat : S 19 : 24.218 Start Lon : E 27 : 7.091
Finish Lat : S 19 : 18.902 Finish Lon : E 27 : 7.091
Length : 9.80 km

Transect # : 4
Start Lat : S 19 : 19.143 Start Lon : E 27 : 12.798
Finish Lat : S 19 : 23.111 Finish Lon : E 27 : 12.798
Length : 7.32 km

Transect # : 5
Start Lat : S 19 : 18.432 Start Lon : E 27 : 18.504
Finish Lat : S 19 : 14.132 Finish Lon : E 27 : 18.504
Length : 7.93 km

Transect # : 6
Start Lat : S 19 : 13.378 Start Lon : E 27 : 24.211
Finish Lat : S 19 : 15.658 Finish Lon : E 27 : 24.211
Length : 4.21 km

Transect # : 7
Start Lat : S 19 : 11.351 Start Lon : E 27 : 29.918
Finish Lat : S 19 : 7.493 Finish Lon : E 27 : 29.918
Length : 7.11 km

Transect # : 8
Start Lat : S 19 : 11.992 Start Lon : E 27 : 35.625
Finish Lat : S 19 : 12.907 Finish Lon : E 27 : 35.625
Length : 0.03 km

Dandari

Number of transects : 25
Transect Bearing : 0.00 Degrees
Transect Spacing : 2.90 km

Transect # : 1
Start Lat : S 18 : 52.403 Start Lon : E 26 : 29.384
Finish Lat : S 18 : 52.335 Finish Lon : E 26 : 29.384
Length : 0.13 km

Transect # : 2
Start Lat : S 18 : 52.036 Start Lon : E 26 : 27.733

Finish Lat : S 18 : 53.580 Finish Lon : E 26 : 27.733
Length : 2.86 km

Transect # : 3
Start Lat : S 18 : 54.114 Start Lon : E 26 : 26.082
Finish Lat : S 18 : 51.765 Finish Lon : E 26 : 26.082
Length : 4.35 km

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Transect # : 4

Start Lat : S 18 : 51.164 Start Lon : E 26 : 24.431
Finish Lat : S 18 : 55.103 Finish Lon : E 26 : 24.431
Length : 7.29 km

Transect # : 5

Start Lat : S 18 : 55.973 Start Lon : E 26 : 22.780
Finish Lat : S 18 : 50.546 Finish Lon : E 26 : 22.780
Length : 10.05 km

Transect # : 6

Start Lat : S 18 : 48.647 Start Lon : E 26 : 21.129
Finish Lat : S 18 : 58.292 Finish Lon : E 26 : 21.129
Length : 17.86 km

Transect # : 7

Start Lat : S 18 : 59.161 Start Lon : E 26 : 19.478
Finish Lat : S 18 : 47.709 Finish Lon : E 26 : 19.478
Length : 21.21 km

Transect # : 8

Start Lat : S 18 : 46.852 Start Lon : E 26 : 17.827
Finish Lat : S 18 : 59.308 Finish Lon : E 26 : 17.827
Length : 23.07 km

Transect # : 9

Start Lat : S 18 : 58.765 Start Lon : E 26 : 16.176
Finish Lat : S 18 : 41.884 Finish Lon : E 26 : 16.176
Length : 31.26 km

Transect # : 10

Start Lat : S 18 : 41.762 Start Lon : E 26 : 14.525
Finish Lat : S 18 : 58.790 Finish Lon : E 26 : 14.525
Length : 31.53 km

Transect # : 11

Start Lat : S 18 : 59.011 Start Lon : E 26 : 12.874
Finish Lat : S 18 : 42.980 Finish Lon : E 26 : 12.874
Length : 29.69 km

Transect # : 12

Start Lat : S 18 : 43.543 Start Lon : E 26 : 11.223
Finish Lat : S 18 : 59.311 Finish Lon : E 26 : 11.223
Length : 29.20 km

Transect # : 13

Start Lat : S 18 : 59.451 Start Lon : E 26 : 9.572
Finish Lat : S 18 : 43.875 Finish Lon : E 26 : 9.572
Length : 28.84 km

Transect # : 14

Start Lat : S 18 : 44.634 Start Lon : E 26 : 7.921
Finish Lat : S 18 : 59.657 Finish Lon : E 26 : 7.921
Length : 27.82 km

Transect # : 15

Start Lat : S 19 : 0.164 Start Lon : E 26 : 6.270
Finish Lat : S 18 : 45.980 Finish Lon : E 26 : 6.270
Length : 26.27 km

Transect # : 16

Start Lat : S 18 : 46.770 Start Lon : E 26 : 4.619
Finish Lat : S 18 : 59.980 Finish Lon : E 26 : 4.619
Length : 24.46 km

Transect # : 17

Start Lat : S 18 : 59.866 Start Lon : E 26 : 2.968
Finish Lat : S 18 : 46.768 Finish Lon : E 26 : 2.968
Length : 24.26 km

Transect # : 18

Start Lat : S 18 : 47.188 Start Lon : E 26 : 1.317
Finish Lat : S 19 : 0.697 Finish Lon : E 26 : 1.317
Length : 25.02 km

Transect # : 19

Start Lat : S 19 : 1.249 Start Lon : E 25 : 59.666
Finish Lat : S 18 : 47.453 Finish Lon : E 25 : 59.666
Length : 25.55 km

Transect # : 20

Start Lat : S 18 : 48.182 Start Lon : E 25 : 58.015
Finish Lat : S 18 : 56.481 Finish Lon : E 25 : 58.015
Length : 15.37 km

Transect # : 21

Start Lat : S 18 : 54.106 Start Lon : E 25 : 56.365
Finish Lat : S 18 : 48.468 Finish Lon : E 25 : 56.365
Length : 10.44 km

Transect # : 22

Start Lat : S 18 : 48.550 Start Lon : E 25 : 54.714
Finish Lat : S 18 : 53.517 Finish Lon : E 25 : 54.714
Length : 9.20 km

Transect # : 23

Start Lat : S 18 : 52.225 Start Lon : E 25 : 53.063
Finish Lat : S 18 : 48.900 Finish Lon : E 25 : 53.063
Length : 6.16 km

Transect # : 24

Start Lat : S 18 : 47.400 Start Lon : E 25 : 51.412
Finish Lat : S 18 : 51.206 Finish Lon : E 25 : 51.412
Length : 7.05 km

Transect # : 25

Start Lat : S 18 : 50.373 Start Lon : E 25 : 49.761
Finish Lat : S 18 : 47.400 Finish Lon : E 25 : 49.761
Length : 5.50 km

Main Camp

Number of transects : 23

Transect Bearing : 41.00 Degrees

Transect Spacing : 2.20 km

Transect # : 1A

Start Lat : S 18 : 48.649 Start Lon : E 26 : 38.986
Finish Lat : S 18 : 47.265 Finish Lon : E 26 : 40.256
Length : 3.40 km

Transect # : 1B

Start Lat : S 18 : 46.998 Start Lon : E 26 : 40.500
Finish Lat : S 18 : 44.303 Finish Lon : E 26 : 42.971
Length : 6.61 km

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Transect # : 2A

Start Lat : S 18 : 40.813 Start Lon : E 26 : 47.832
Finish Lat : S 18 : 42.911 Finish Lon : E 26 : 45.908
Length : 5.15 km

Transect # : 2B

Start Lat : S 18 : 43.438 Start Lon : E 26 : 45.425
Finish Lat : S 18 : 50.922 Finish Lon : E 26 : 38.563
Length : 18.36 km

Transect # : 3

Start Lat : S 18 : 50.669 Start Lon : E 26 : 40.455
Finish Lat : S 18 : 37.815 Finish Lon : E 26 : 52.241
Length : 31.54 km

Transect # : 4

Start Lat : S 18 : 38.578 Start Lon : E 26 : 53.202
Finish Lat : S 18 : 50.199 Finish Lon : E 26 : 42.547
Length : 28.51 km

Transect # : 5

Start Lat : S 18 : 49.611 Start Lon : E 26 : 44.746
Finish Lat : S 18 : 39.341 Finish Lon : E 26 : 54.163
Length : 25.20 km

Transect # : 6

Start Lat : S 18 : 40.104 Start Lon : E 26 : 55.124
Finish Lat : S 18 : 49.671 Finish Lon : E 26 : 46.351
Length : 23.48 km

Transect # : 7

Start Lat : S 18 : 49.669 Start Lon : E 26 : 48.014
Finish Lat : S 18 : 40.867 Finish Lon : E 26 : 56.084
Length : 21.60 km

Transect # : 8

Start Lat : S 18 : 41.630 Start Lon : E 26 : 57.045
Finish Lat : S 18 : 51.441 Finish Lon : E 26 : 48.049
Length : 24.07 km

Transect # : 9

Start Lat : S 18 : 52.473 Start Lon : E 26 : 48.763
Finish Lat : S 18 : 42.393 Finish Lon : E 26 : 58.006
Length : 24.73 km

Transect # : 10

Start Lat : S 18 : 43.156 Start Lon : E 26 : 58.967
Finish Lat : S 18 : 53.779 Finish Lon : E 26 : 49.226
Length : 26.07 km

Transect # : 11

Start Lat : S 18 : 54.986 Start Lon : E 26 : 49.780
Finish Lat : S 18 : 43.919 Finish Lon : E 26 : 59.928
Length : 27.16 km

Transect # : 12

Start Lat : S 18 : 44.682 Start Lon : E 27 : 0.888
Finish Lat : S 18 : 55.938 Finish Lon : E 26 : 50.568
Length : 27.62 km

Transect # : 13

Start Lat : S 18 : 57.178 Start Lon : E 26 : 51.091
Finish Lat : S 18 : 45.445 Finish Lon : E 27 : 1.849
Length : 28.79 km

Transect # : 14

Start Lat : S 18 : 46.208 Start Lon : E 27 : 2.810
Finish Lat : S 18 : 58.296 Finish Lon : E 26 : 51.726
Length : 29.66 km

Transect # : 15

Start Lat : S 18 : 59.082 Start Lon : E 26 : 52.666
Finish Lat : S 18 : 46.971 Finish Lon : E 27 : 3.771
Length : 29.72 km

Transect # : 16

Start Lat : S 18 : 47.734 Start Lon : E 27 : 4.731
Finish Lat : S 18 : 59.399 Finish Lon : E 26 : 54.035
Length : 28.62 km

Transect # : 17

Start Lat : S 19 : 0.322 Start Lon : E 26 : 54.850
Finish Lat : S 18 : 48.497 Finish Lon : E 27 : 5.692
Length : 29.02 km

Transect # : 18

Start Lat : S 18 : 49.260 Start Lon : E 27 : 6.653
Finish Lat : S 19 : 1.423 Finish Lon : E 26 : 55.500
Length : 29.85 km

Transect # : 19

Start Lat : S 19 : 2.458 Start Lon : E 26 : 56.212
Finish Lat : S 18 : 50.023 Finish Lon : E 27 : 7.614
Length : 30.51 km

Transect # : 20

Start Lat : S 18 : 50.786 Start Lon : E 27 : 8.574
Finish Lat : S 19 : 3.103 Finish Lon : E 26 : 57.281
Length : 30.22 km

Transect # : 21

Start Lat : S 19 : 4.043 Start Lon : E 26 : 58.079
Finish Lat : S 18 : 53.767 Finish Lon : E 27 : 7.502
Length : 25.21 km

Transect # : 22

Start Lat : S 18 : 57.485 Start Lon : E 27 : 5.753
Finish Lat : S 19 : 4.860 Finish Lon : E 26 : 58.990
Length : 18.10 km

Transect # : 23

Start Lat : S 19 : 4.200 Start Lon : E 27 : 1.256
Finish Lat : S 19 : 2.097 Finish Lon : E 27 : 3.184
Length : 5.16 km

Central B

Number of transects : 4
Transect Bearing : -26.00 Degrees
Transect Spacing : 9.50 km

Transect # : 1
Start Lat : S 19 : 6.750 Start Lon : E 26 : 24.681
Finish Lat : S 19 : 24.443 Finish Lon : E 26 : 33.802
Length : 36.45 km

Transect # : 2
Start Lat : S 19 : 23.719 Start Lon : E 26 : 39.461
Finish Lat : S 19 : 3.576 Finish Lon : E 26 : 29.077
Length : 41.50 km

Transect # : 3
Start Lat : S 19 : 1.767 Start Lon : E 26 : 34.177
Finish Lat : S 19 : 22.945 Finish Lon : E 26 : 45.094
Length : 43.63 km

Transect # : 4
Start Lat : S 19 : 21.253 Start Lon : E 26 : 50.254
Finish Lat : S 18 : 58.650 Finish Lon : E 26 : 38.603
Length : 46.57 km

Central A

Number of transects : 12
Transect Bearing : 66.00 Degrees
Transect Spacing : 3.90 km

Transect # : 1
Start Lat : S 18 : 57.900 Start Lon : E 26 : 45.472
Finish Lat : S 18 : 59.096 Finish Lon : E 26 : 42.631
Length : 5.45 km

Transect # : 2
Start Lat : S 19 : 1.001 Start Lon : E 26 : 43.582
Finish Lat : S 18 : 57.725 Finish Lon : E 26 : 51.360
Length : 14.92 km

Transect # : 3
Start Lat : S 18 : 59.290 Start Lon : E 26 : 53.119
Finish Lat : S 19 : 2.906 Finish Lon : E 26 : 44.532
Length : 16.46 km

Transect # : 4
Start Lat : S 19 : 4.811 Start Lon : E 26 : 45.483
Finish Lat : S 19 : 0.737 Finish Lon : E 26 : 55.157
Length : 18.55 km

Transect # : 5
Start Lat : S 19 : 2.554 Start Lon : E 26 : 56.316
Finish Lat : S 19 : 6.716 Finish Lon : E 26 : 46.433
Length : 18.95 km

Transect # : 6
Start Lat : S 19 : 8.621 Start Lon : E 26 : 47.384
Finish Lat : S 19 : 4.103 Finish Lon : E 26 : 58.113
Length : 20.57 km

Transect # : 7
Start Lat : S 19 : 5.792 Start Lon : E 26 : 59.576
Finish Lat : S 19 : 10.526 Finish Lon : E 26 : 48.334
Length : 21.56 km

Transect # : 8
Start Lat : S 19 : 12.431 Start Lon : E 26 : 49.285
Finish Lat : S 19 : 7.801 Finish Lon : E 27 : 0.278
Length : 21.08 km

Transect # : 9
Start Lat : S 19 : 10.051 Start Lon : E 27 : 0.411
Finish Lat : S 19 : 14.336 Finish Lon : E 26 : 50.235
Length : 19.51 km

Transect # : 10
Start Lat : S 19 : 16.241 Start Lon : E 26 : 51.186
Finish Lat : S 19 : 12.155 Finish Lon : E 27 : 0.889
Length : 18.61 km

Transect # : 11
Start Lat : S 19 : 14.726 Start Lon : E 27 : 0.258
Finish Lat : S 19 : 18.146 Finish Lon : E 26 : 52.136
Length : 15.57 km

Transect # : 12A
Start Lat : S 19 : 20.051 Start Lon : E 26 : 53.087
Finish Lat : S 19 : 18.218 Finish Lon : E 26 : 57.440
Length : 8.35 km

Transect # : 12B
Start Lat : S 19 : 17.692 Start Lon : E 26 : 58.690
Finish Lat : S 19 : 17.397 Finish Lon : E 26 : 59.389
Length : 1.34 km

Ngamo

Number of transects : 22
Transect Bearing : -52.00 Degrees
Transect Spacing : 2.50 km

Transect # : 1
Start Lat : S 18 : 52.166 Start Lon : E 27 : 8.550
Finish Lat : S 19 : 6.253 Finish Lon : E 27 : 27.595
Length : 42.37 km

Transect # : 2
Start Lat : S 19 : 7.468 Start Lon : E 27 : 26.921
Finish Lat : S 18 : 53.188 Finish Lon : E 27 : 7.616
Length : 42.95 km

Transect # : 3
Start Lat : S 18 : 54.830 Start Lon : E 27 : 7.519
Finish Lat : S 19 : 8.958 Finish Lon : E 27 : 26.620
Length : 42.50 km

Transect # : 4
Start Lat : S 19 : 11.282 Start Lon : E 27 : 27.445
Finish Lat : S 18 : 55.959 Finish Lon : E 27 : 6.730
Length : 46.09 km

Transect # : 5
Start Lat : S 18 : 57.037 Start Lon : E 27 : 5.871
Finish Lat : S 19 : 12.546 Finish Lon : E 27 : 26.838
Length : 46.65 km

Transect # : 6
Start Lat : S 19 : 13.032 Start Lon : E 27 : 25.178
Finish Lat : S 18 : 58.249 Finish Lon : E 27 : 5.194
Length : 44.46 km

Transect # : 7
Start Lat : S 18 : 59.271 Start Lon : E 27 : 4.259
Finish Lat : S 19 : 13.612 Finish Lon : E 27 : 23.647
Length : 43.14 km

Transect # : 8
Start Lat : S 19 : 13.357 Start Lon : E 27 : 20.986
Finish Lat : S 19 : 0.300 Finish Lon : E 27 : 3.334
Length : 39.27 km

Transect # : 9
Start Lat : S 19 : 1.381 Start Lon : E 27 : 2.479
Finish Lat : S 19 : 13.791 Finish Lon : E 27 : 19.257
Length : 37.33 km

Transect # : 10
Start Lat : S 19 : 14.446 Start Lon : E 27 : 17.826
Finish Lat : S 19 : 3.417 Finish Lon : E 27 : 2.916
Length : 33.18 km

Transect # : 11
Start Lat : S 19 : 4.098 Start Lon : E 27 : 1.520
Finish Lat : S 19 : 15.359 Finish Lon : E 27 : 16.745
Length : 33.87 km

Transect # : 12
Start Lat : S 19 : 16.216 Start Lon : E 27 : 15.587
Finish Lat : S 19 : 4.526 Finish Lon : E 26 : 59.783
Length : 35.16 km

Transect # : 13
Start Lat : S 19 : 6.641 Start Lon : E 27 : 0.326
Finish Lat : S 19 : 17.153 Finish Lon : E 27 : 14.537
Length : 31.62 km

Transect # : 14
Start Lat : S 19 : 18.387 Start Lon : E 27 : 13.890
Finish Lat : S 19 : 8.337 Finish Lon : E 27 : 0.304
Length : 30.23 km

Transect # : 15
Start Lat : S 19 : 10.187 Start Lon : E 27 : 0.488
Finish Lat : S 19 : 19.156 Finish Lon : E 27 : 12.614
Length : 26.98 km

Transect # : 16A
Start Lat : S 19 : 18.965 Start Lon : E 27 : 10.039
Finish Lat : S 19 : 12.656 Finish Lon : E 27 : 1.511
Length : 18.98 km

Transect # : 16B
Start Lat : S 19 : 12.576 Start Lon : E 27 : 1.401
Finish Lat : S 19 : 12.197 Finish Lon : E 27 : 0.889
Length : 1.14 km

Transect # : 17
Start Lat : S 19 : 13.951 Start Lon : E 27 : 0.944
Finish Lat : S 19 : 18.914 Finish Lon : E 27 : 7.654
Length : 14.93 km

Transect # : 18
Start Lat : S 19 : 19.241 Start Lon : E 27 : 5.780
Finish Lat : S 19 : 15.089 Finish Lon : E 27 : 0.167
Length : 12.49 km

Transect # : 19
Start Lat : S 19 : 16.453 Start Lon : E 26 : 59.694
Finish Lat : S 19 : 19.554 Finish Lon : E 27 : 3.887
Length : 9.33 km

Transect # : 20
Start Lat : S 19 : 19.711 Start Lon : E 27 : 1.783
Finish Lat : S 19 : 17.634 Finish Lon : E 26 : 58.975
Length : 6.25 km

Transect # : 21
Start Lat : S 19 : 18.213 Start Lon : E 26 : 57.443
Finish Lat : S 19 : 19.781 Finish Lon : E 26 : 59.561
Length : 4.71 km

Transect # : 22
Start Lat : S 19 : 20.297 Start Lon : E 26 : 57.944
Finish Lat : S 19 : 18.900 Finish Lon : E 26 : 56.055
Length : 4.20 km

Sikumi Forest

Number of transects : 9

Transect Bearing : 41.00 Degrees

Transect Spacing : 7.10 km

Transect # : 1

Start Lat : S 18 : 36.511 Start Lon : E 26 : 52.000

Finish Lat : S 18 : 32.425 Finish Lon : E 26 : 55.743

Length : 10.03 km

Transect # : 2

Start Lat : S 18 : 33.280 Start Lon : E 27 : 0.314

Finish Lat : S 18 : 39.616 Finish Lon : E 26 : 54.509

Length : 15.55 km

Transect # : 3

Start Lat : S 18 : 42.077 Start Lon : E 26 : 57.608

Finish Lat : S 18 : 35.617 Finish Lon : E 27 : 3.527

Length : 15.85 km

Transect # : 4

Start Lat : S 18 : 37.125 Start Lon : E 27 : 7.499

Finish Lat : S 18 : 44.538 Finish Lon : E 27 : 0.707

Length : 18.19 km

Transect # : 5

Start Lat : S 18 : 47.000 Start Lon : E 27 : 3.807

Finish Lat : S 18 : 37.500 Finish Lon : E 27 : 12.510

Length : 23.31 km

Transect # : 6

Start Lat : S 18 : 41.050 Start Lon : E 27 : 14.611

Finish Lat : S 18 : 49.461 Finish Lon : E 27 : 6.906

Length : 20.64 km

Transect # : 7

Start Lat : S 18 : 51.921 Start Lon : E 27 : 10.006

Finish Lat : S 18 : 43.151 Finish Lon : E 27 : 18.040

Length : 21.52 km

Transect # : 8

Start Lat : S 18 : 44.400 Start Lon : E 27 : 22.250

Finish Lat : S 18 : 54.379 Finish Lon : E 27 : 13.108

Length : 24.49 km

Transect # : 9

Start Lat : S 18 : 56.837 Start Lon : E 27 : 16.210

Finish Lat : S 18 : 45.750 Finish Lon : E 27 : 26.367

Length : 27.20 km

Appendix 4. Transect summaries of sightings

Species codes:

Code	Species
Bbk	Bushbuck
BRh	Black rhino
Buff	Buffalo
Camp	Poachers' camp
Catt	Cattle
Croc	Crocodile
Dkr	Common Duiker
Donk	Donkey
EIC1	Elephant carcass, age category 1
EIC2	Elephant carcass, age category 2
EIC3	Elephant carcass, age category 3
EIC4	Elephant carcass, age category 4
Eld	Eland
EleF	Elephant cow
EleM	Elephant bull
Ghb	Ground hornbill
Grf	Giraffe
Hipo	Hippopotamus
Imp	Impala
Jack	Jackal
Kudu	Kudu
Lion	Lion
Ost	Ostrich
Roan	Roan antelope
Rhin	Rhino (species not recorded)
Sab	Sable
Sbk	Steinbuck
Shoa	Sheep and/or goats
UnCa	Carcass of unidentified species
Wbck	Waterbuck
Wbst	Wildebeest
Whog	Warthog
WRh	White rhino
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, <i>P</i> = 0.05
T #	transect number
-	no animals were seen in search strips

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

Date of Survey : 09/11/07	Stratum Name : Central A
Stratum Locality : NW Matabeleland	Base Line Length : 44.8 km
Stratum Area : 775 km ²	Calibrated Strip Width at 300ft : 328 m
N : 136	t : 2.201
Pilot : C Mackie	Observer : G Mtare / C Zhuwau
Map overlay file : None	

Transect summary table :

T #	EleM	EleF	Sab	Imp	EIC4	UnCa	Grf	Dkr	Sbk
1	1	-	-	-	-	-	-	-	-
2	2	7	-	-	-	-	-	-	-
3	14	18	-	-	-	-	1	1	-
4	-	-	1	-	-	1	-	-	-
5	1	-	-	-	1	-	1	-	-
6	4	-	-	-	-	-	-	-	-
7	4	6	-	3	-	-	-	2	-
8	-	-	-	-	-	-	-	-	-
9	3	7	-	-	1	-	4	-	2
10	3	42	-	-	-	-	-	-	-
11	-	-	-	-	1	-	-	-	-
12	2	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Sab	Imp	EIC4	UnCa	Grf	Dkr	Sbk
	34	80	1	3	3	1	6	3	2

Date of Survey : 07/11/07	Stratum Name : Central B
Stratum Locality : NW Matabeleland	Base Line Length : 42 km
Stratum Area : 1723 km ²	Calibrated Strip Width at 300ft : 328 m
N : 127	t : 3.182
Pilot : C Mackie	Observer : G Mtare / C Zhuwau
Map overlay file : None	

Transect summary table :

T #	EleM	EleF	Zeb	EIC4	Roan	Grf	WRh	Ghb
1	2	7	-	-	-	-	-	-
2	1	17	1	1	1	-	-	-
3	12	6	-	-	-	-	-	-
4	19	39	-	-	-	1	1	1

Sighting Totals

	EleM	EleF	Zeb	EIC4	Roan	Grf	WRh	Ghb
	34	69	1	1	1	1	1	1

Date of Survey : 05/11/07

Stratum Locality : NW Matabeleland

Stratum Area : 1290 km²

N : 217 n : 25

Pilot : C Mackie

Map overlay file : None

Stratum Name : Dandari

Base Line Length : 71.8 km

Calibrated Strip Width at 300ft : 328 m

t : 2.064

Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	Sab	Zeb	Kudu	EIC1	EIC4	UnCa	Grf	Whog	Ost	Eld	Ghb	Dkr
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	21	11	9	-	-	-	-	3	-	-	-	-	-	-	-
7	1	6	-	-	-	-	-	-	-	-	-	-	-	-	-
8	4	21	2	-	-	-	-	1	-	-	-	-	-	-	-
9	8	54	-	-	-	-	-	3	-	-	-	-	-	-	-
10	8	85	-	-	-	-	-	-	-	-	-	-	-	-	-
11	9	14	-	-	-	1	-	-	-	1	-	-	-	-	-
12	10	41	-	-	-	-	-	1	1	-	-	-	-	-	-
13	4	41	-	-	-	-	-	1	-	-	1	-	-	-	-
14	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-
15	6	8	-	-	-	-	-	-	-	-	-	-	-	-	-
16	6	18	-	4	-	-	-	-	-	-	-	-	-	4	-
17	8	5	-	-	5	-	-	1	-	1	1	-	-	-	-
18	6	12	-	-	-	-	-	-	-	-	-	-	-	-	-
19	3	63	-	-	-	-	1	1	-	-	-	1	2	-	1
20	-	18	-	-	-	-	-	-	-	-	-	-	-	-	-
21	7	14	-	-	-	-	-	-	-	-	-	-	-	-	-
22	14	-	-	-	-	-	-	-	-	-	-	-	1	-	-
23	-	23	-	-	10	-	-	2	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
25	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Buff	Sab	Zeb	Kudu	EIC1	EIC4	UnCa	Grf	Whog	Ost	Eld	Ghb	Dkr
	122	438	11	4	15	1	1	17	1	2	2	1	3	4	1

Date of Survey : 08/11/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 2098 km²
 N : 185 n : 14
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Dzivanini
 Base Line Length : 61.1 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.16
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	Sab	Zeb	EIC2	EIC4	UnCa	Grf	Roan	Ghb
1	13	25	-	-	-	-	-	-	-	-	-
2	13	28	-	-	-	1	-	-	-	-	-
3	30	86	-	-	-	1	-	-	-	-	-
4	28	52	-	-	1	-	2	-	4	-	-
5	32	28	-	-	-	-	-	-	-	-	-
6	13	69	-	-	-	-	1	1	-	-	-
7	12	12	-	-	-	-	-	1	-	-	-
8	4	48	1	-	-	-	-	-	2	-	-
9	4	85	-	1	-	-	-	-	2	-	-
10	5	12	-	-	-	-	-	1	1	-	-
11	10	-	-	-	-	-	1	-	-	4	2
12	-	-	-	-	-	-	-	1	-	-	-
13	-	-	-	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	1	-	-	-

Sighting Totals

	EleM	EleF	Buff	Sab	Zeb	EIC2	EIC4	UnCa	Grf	Roan	Ghb
	164	445	1	1	1	2	5	4	9	4	2

Date of Survey : 28/10/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 561 km²
 N : 96 n : 7
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Kazuma
 Base Line Length : 32.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.447
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	Sab	Zeb	Kudu	EIC3	EIC4	UnCa	Eld	Grf	Ost	Ghb
1	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-
3	-	-	-	1	1	1	3	-	-	-
4	3	-	-	-	1	1	-	-	-	-
5	2	-	6	2	3	1	-	-	2	4
6	-	22	6	-	2	2	-	-	-	-
7	1	15	-	-	-	-	-	1	-	-

Sighting Totals

	Sab	Zeb	Kudu	EIC3	EIC4	UnCa	Eld	Grf	Ost	Ghb
	6	37	12	3	7	5	3	1	2	4

Date of Survey : 27/10/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 446 km²
 N : 106 n : 15
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Kazungula
 Base Line Length : 35.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.145
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Sab	Hipo	EIC2	EIC3	EIC4	UnCa	Grf	Whog	Croc
1	4	-	-	-	-	-	2	-	-	-	-
2	2	-	-	-	1	-	1	2	-	-	-
3	-	-	-	-	-	-	-	1	-	-	-
4	-	-	5	-	-	-	2	1	3	-	-
5	-	15	1	-	-	-	-	-	1	-	2
6	-	-	2	-	1	-	-	1	-	-	-
7	-	-	36	-	-	2	-	-	-	-	-
8	-	-	6	-	1	-	-	-	-	-	-
9	-	-	-	2	-	-	1	-	-	-	-
10	-	-	3	-	1	-	4	2	-	-	-
11	1	-	23	-	1	2	1	1	-	2	1
12	-	-	-	-	1	-	3	3	-	-	-
13	-	-	-	-	-	-	1	2	-	-	-
14	-	-	-	-	1	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Sab	Hipo	EIC2	EIC3	EIC4	UnCa	Grf	Whog	Croc
	7	15	76	2	7	4	15	13	4	2	3

Date of Survey : 10/11/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 1224 km²
 N : 158 n : 6
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Maitengwe
 Base Line Length : 51.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.571
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EIC4	UnCa	Catt	Shoa	Donk	Dkr
1	-	-	31	-	1	-
2	-	1	-	5	-	1
3	1	-	-	-	-	-
4	-	-	-	-	-	-
5	-	-	1	-	-	-
6	-	-	-	-	-	-

Sighting Totals

	EIC4	UnCa	Catt	Shoa	Donk	Dkr
	1	1	32	5	1	1

Date of Survey : 05/11/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 1261 km²
 N : 152 n : 23
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Main Camp
 Base Line Length : 50.8 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.074
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	Sab	Imp	Kudu	EIC1	EIC2	EIC4	UnCa	Grf	Ost	Ghb	Sbk
1	-	10	-	-	-	-	-	-	-	2	-	-	-	-
2	5	-	8	-	-	-	-	1	1	1	-	-	3	-
3	-	12	-	-	-	-	-	-	1	-	1	-	-	-
4	6	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	1	1	5	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	1	-	-	-	-	2	1	-	-	-	-
8	1	4	-	-	-	-	-	2	1	1	11	5	-	-
9	1	-	-	-	4	7	-	-	3	2	2	-	-	-
10	-	-	-	-	-	-	1	-	-	-	-	-	-	-
11	3	-	-	15	-	-	-	-	2	-	-	-	-	-
12	1	9	-	-	-	2	-	-	5	2	-	-	-	-
13	-	9	-	-	-	-	-	-	1	-	-	-	-	-
14	10	25	-	-	-	-	-	-	4	-	1	-	-	1
15	-	-	-	-	-	1	-	-	5	-	2	-	-	-
16	3	41	-	-	-	-	-	-	-	-	-	-	-	-
17	7	6	-	-	2	-	-	-	-	-	2	-	-	-
18	5	7	-	-	-	-	-	-	1	-	-	-	-	-
19	3	14	-	-	-	-	-	-	-	-	-	-	-	-
20	4	45	-	-	-	-	-	-	1	-	-	-	-	-
21	5	25	8	-	-	-	-	-	-	-	-	-	-	-
22	3	24	-	-	-	-	-	-	-	-	-	-	-	-
23	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Buff	Sab	Imp	Kudu	EIC1	EIC2	EIC4	UnCa	Grf	Ost	Ghb	Sbk
	60	231	16	16	6	10	1	3	28	10	24	5	3	1

Date of Survey : 29/10/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 344 km²
 N : 62 n : 5
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Rosslyn
 Base Line Length : 21.8 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.776
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	Sab	Zeb	Imp	Kudu	EIC4	UnCa	Eld	Whog	Grf	Sbk
1	-	20	-	-	-	-	-	-	-	-	-
2	-	12	22	6	1	-	1	2	4	-	-
3	-	-	4	-	-	3	1	-	-	1	1
4	1	5	-	-	-	1	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	Sab	Zeb	Imp	Kudu	EIC4	UnCa	Eld	Whog	Grf	Sbk
	1	37	26	6	1	4	2	2	4	1	1

Aerial Survey of Elephants and other Herbivores in NW Matabeleland, Zimbabwe: 2007

Date of Survey : 29/10/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 703 km²
 N : 120 n : 6
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Matetsi
 Base Line Length : 39.5 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.571
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	Buff	Sab	Zeb	Wbck	Imp	Kudu	EIC3	EIC4	UnCa	Grf	Whog	Sbk	Roan	Wbst	Jack
1	-	-	1	2	-	1	-	-	-	-	5	1	-	-	-	-
2	-	5	-	-	-	-	-	-	-	-	-	1	1	-	-	-
3	-	488	-	11	4	6	2	-	1	-	1	2	-	1	-	-
4	12	-	-	25	10	10	4	-	-	-	3	-	-	-	-	2
5	-	10	12	21	-	3	10	1	1	1	3	-	-	-	-	-
6	-	-	-	8	30	20	4	-	-	1	5	8	1	-	12	-

Sighting Totals

	EleM	Buff	Sab	Zeb	Wbck	Imp	Kudu	EIC3	EIC4	UnCa	Grf	Whog	Sbk	Roan	Wbst	Jack
	12	503	13	67	44	40	20	1	2	2	17	12	2	1	12	2

Date of Survey : 30/10/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 826 km²
 N : 163 n : 18
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Mtoa
 Base Line Length : 53.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.11
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	Sab	Zeb	Kudu	EIC1	EIC2	EIC3	EIC4	UnCa	Camp	Catt	Grf	Sbk
1	-	-	-	-	2	-	-	-	-	-	2	1	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
3	1	2	-	-	-	-	-	-	-	-	-	-	1	-	-
4	3	2	-	-	-	-	-	-	-	-	1	1	-	-	-
5	2	16	-	-	-	-	-	-	-	-	-	-	1	-	1
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	1	5	-	-	-	-	-	-	-	-	3	1	-	-	1
8	12	-	-	11	-	2	-	-	-	-	2	-	-	-	1
9	9	4	-	-	-	-	-	-	-	-	-	-	-	-	-
10	2	8	-	-	-	-	-	-	-	-	2	1	-	-	-
11	3	18	-	-	-	-	-	-	-	-	1	-	-	-	1
12	2	8	-	-	-	-	-	1	-	-	1	-	-	-	-
13	11	24	-	-	-	-	1	-	-	-	2	-	-	-	2
14	1	-	10	-	-	-	-	-	-	-	-	-	-	-	-
15	5	5	-	-	-	-	-	-	-	-	-	-	7	-	-
16	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
17	-	-	-	-	4	-	-	-	1	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-

Sighting Totals

	EleM	EleF	Buff	Sab	Zeb	Kudu	EIC1	EIC2	EIC3	EIC4	UnCa	Camp	Catt	Grf	Sbk	
	52	92	10	11	6	2	1	1	1	1	15	6	2	7	5	1

Aerial Survey of Elephants and other Herbivores in NW Matabeleland, Zimbabwe: 2007

Date of Survey : 07/11/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 1629 km²
 N : 172 n : 22
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Ngamo
 Base Line Length : 56.8 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.08
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	Sab	Zeb	Wbck	Kudu	EIC4	UnCa	Wbst	WRh	Ost	Eld	Grf	Ghb	Sbk	Dkr
1	3	-	-	17	5	-	-	3	5	34	-	-	-	-	-	-	-
2	2	32	-	3	2	-	-	-	3	-	2	2	-	-	-	-	-
3	-	31	-	12	-	-	-	1	1	13	-	-	1	-	1	-	-
4	3	19	55	-	7	-	-	2	1	1	-	-	-	5	-	-	-
5	2	-	-	-	2	-	2	1	2	-	-	-	-	-	3	-	-
6	5	7	-	15	-	5	-	2	2	40	1	-	-	-	-	-	-
7	1	-	124	-	-	-	-	4	3	-	-	-	-	-	-	1	-
8	1	6	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-
9	1	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
10	-	-	5	-	-	-	-	2	3	-	-	-	-	-	-	-	-
11	2	12	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
12	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
13	4	6	-	1	-	-	-	2	-	-	-	-	-	-	-	-	-
14	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
15	1	9	-	-	-	-	-	1	-	-	-	-	-	3	-	-	2
16	12	37	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-
17	5	17	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-
18	1	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

EleM	EleF	Buff	Sab	Zeb	Wbck	Kudu	EIC4	UnCa	Wbst	WRh	Ost	Eld	Grf	Ghb	Sbk	Dkr
45	178	184	48	17	5	2	26	24	88	3	2	1	11	4	1	2

Date of Survey : 08/11/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 1171 km²
 N : 131 n : 5
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Ngamo Forest
 Base Line Length : 43.5 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.776
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	EIC4	UnCa	Catt	Wbst	Dkr
1	-	73	30	1	-	-	-	-
2	-	-	-	1	8	28	50	1
3	4	-	-	-	3	-	-	-
4	-	-	-	-	-	22	-	-
5	-	-	-	-	-	-	10	-

Sighting Totals

EleM	EleF	Buff	EIC4	UnCa	Catt	Wbst	Dkr
4	73	30	2	11	60	50	1

Date of Survey : 28/10/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 963 km²
 N : 162 n : 11
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Panda Masuie
 Base Line Length : 54.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.228
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Sab	Zeb	Kudu	EIC4	UnCa	Grf	Sbk	Ost
1	-	-	3	-	-	-	-	-	-	-
2	-	-	-	-	-	-	1	-	-	-
3	3	-	1	-	1	2	1	3	-	-
4	-	17	-	-	-	2	-	-	-	-
5	-	-	-	10	-	2	-	2	-	2
6	-	-	-	-	-	-	2	-	-	-
7	-	-	-	19	-	-	-	2	1	-
8	-	-	-	-	-	-	-	-	-	-
9	-	-	-	7	-	3	1	-	-	-
10	-	12	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Sab	Zeb	Kudu	EIC4	UnCa	Grf	Sbk	Ost
	3	29	4	36	1	9	5	7	1	2

Date of Survey : 30/10/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 1029 km²
 N : 107 n : 14
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Robins
 Base Line Length : 35.8 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.16
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	Sab	Zeb	Wbck	Imp	Kudu	EIC2	EIC4	UnCa	Dkr	Whog	Eld	Roan	Grf	Ost	Lion
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	3	-	7	-	5	-	6	-	-	-	-	-	-	-	-	-	-	-
3	3	24	1	-	4	-	8	-	-	-	-	1	-	-	-	-	-	-
4	4	22	-	7	-	-	-	4	-	1	-	-	-	-	-	-	-	-
5	-	-	-	-	9	-	16	-	-	3	-	-	4	-	-	-	-	-
6	-	-	-	1	8	20	-	2	-	-	1	2	4	1	-	-	-	-
7	-	12	-	4	3	1	134	-	-	2	4	-	2	-	5	-	-	2
8	-	-	-	-	1	30	23	8	-	-	1	2	2	-	-	-	-	-
9	4	-	-	-	12	-	46	-	-	2	-	-	-	-	-	-	-	-
10	-	30	-	-	10	-	-	-	1	1	-	-	-	-	1	-	-	-
11	4	-	-	-	-	-	-	-	-	3	2	-	-	-	3	-	3	-
12	8	14	-	-	-	-	-	-	-	1	1	-	-	-	3	1	-	-
13	-	23	-	-	-	-	-	-	-	2	-	1	-	-	1	-	-	-
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Buff	Sab	Zeb	Wbck	Imp	Kudu	EIC2	EIC4	UnCa	Dkr	Whog	Eld	Roan	Grf	Ost	Lion
	26	125	8	12	52	51	233	14	1	15	9	6	12	1	9	4	4	2

Date of Survey : 06/11/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 2143 km²
 N : 201 n : 11
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Shakwanki
 Base Line Length : 66.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.228
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Zeb	EIC4	Grf	Dkr	Sbk
1	1	7	-	-	-	-	-
2	-	-	-	-	-	-	-
3	1	-	-	1	1	-	-
4	7	-	-	-	1	-	-
5	2	-	-	-	-	1	2
6	1	5	-	1	-	-	-
7	16	12	-	2	-	-	-
8	7	43	-	-	1	-	-
9	-	8	6	-	-	-	1
10	2	12	-	1	-	-	-
11	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Zeb	EIC4	Grf	Dkr	Sbk
	37	87	6	5	3	1	3

Date of Survey : 29/10/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 839 km²
 N : 109 n : 8
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Zanguja
 Base Line Length : 37.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.365
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleF	Buff	Sab	Zeb	Wbck	Imp	Kudu	EIC4	UnCa	Camp	Catt	Grf	Whog	Dkr	Roan
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	2	80	21	-	1	-	12	-	1	-	-	2	1	-	-
3	25	30	23	14	-	7	5	-	-	-	-	4	-	-	-
4	-	-	10	-	5	-	-	1	2	-	-	-	-	1	-
5	8	-	6	14	1	6	-	1	2	1	6	-	-	-	1
6	4	-	-	-	-	-	-	-	-	-	4	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3
8	2	-	-	4	-	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleF	Buff	Sab	Zeb	Wbck	Imp	Kudu	EIC4	UnCa	Camp	Catt	Grf	Whog	Dkr	Roan
	41	110	60	32	7	13	17	2	5	1	10	6	1	2	4

Date of Survey : 01/11/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 923 km²
 N : 172 n : 21
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Shapi
 Base Line Length : 57.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.086
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	Sab	Zeb	EIC4	UnCa	Grf	Whog	Ghb
1	-	-	-	-	-	-	-	-	-	-
2	7	38	-	-	-	-	-	-	-	-
3	19	33	3	-	-	-	2	-	-	-
4	17	69	-	-	3	-	-	-	-	-
5	11	28	-	-	-	-	1	-	-	-
6	-	17	-	-	-	-	1	1	-	-
7	-	2	-	-	-	-	-	1	-	-
8	-	-	-	-	-	-	-	-	-	-
9	3	30	-	-	-	-	1	-	-	-
10	20	76	-	-	-	-	-	1	1	-
11	10	38	-	2	-	1	1	-	-	-
12	27	97	-	-	-	1	-	1	-	-
13	16	20	-	-	-	1	-	-	-	-
14	1	15	-	-	-	1	-	-	-	-
15	18	8	-	-	-	2	-	-	-	-
16	4	-	-	-	-	-	-	-	-	-
17	2	7	-	-	-	1	-	-	-	-
18	7	10	-	-	-	1	-	-	-	-
19	4	10	-	-	-	1	-	-	-	3
20	4	-	-	-	-	-	-	-	-	-
21	-	-	-	-	-	-	-	-	-	-

Sighting Totals

	EleM	EleF	Buff	Sab	Zeb	EIC4	UnCa	Grf	Whog	Ghb
	170	498	3	2	3	9	6	4	1	3

Date of Survey : 06/11/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 1173 km²
 N : 181 n : 9
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Sikumi Forest
 Base Line Length : 60.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.306
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	Imp	EIC3	EIC4	UnCa	Catt	Roan
1	1	29	-	-	-	-	-	-	-
2	-	-	450	-	-	2	-	23	-
3	-	-	-	-	-	3	1	-	-
4	-	-	-	-	-	1	1	-	-
5	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	2	1	-	-
7	-	-	-	30	-	-	-	-	-
8	-	-	-	-	-	1	-	-	-
9	-	-	-	-	2	1	2	-	2

Sighting Totals

	EleM	EleF	Buff	Imp	EIC3	EIC4	UnCa	Catt	Roan
	1	29	450	30	2	10	5	23	2

Aerial Survey of Elephants and other Herbivores in NW Matabeleland, Zimbabwe: 2007

Date of Survey : 31/10/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 1522 km²
 N : 169 n : 20
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Sinamatella
 Base Line Length : 57.5 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.093
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	Zeb	Imp	Kudu	EIC2	EIC3	EIC4	UnCa	Grf	Whog	Dkr	Ghb	Rhin	Bbk	BRh
1	1	-	-	4	45	-	-	-	-	-	2	-	-	-	-	-	-
2	-	10	-	-	2	3	-	-	-	-	-	1	-	-	-	-	-
3	-	-	3	10	50	-	-	-	1	-	-	1	1	-	-	-	-
4	-	9	-	4	-	-	1	-	2	2	1	-	-	2	2	-	1
5	1	8	-	17	17	5	-	-	5	2	-	2	1	-	-	-	-
6	9	60	-	-	-	3	-	1	1	1	4	4	-	-	1	3	-
7	-	30	-	-	11	-	-	-	1	2	-	-	-	-	-	-	-
8	-	7	-	-	1	2	-	-	2	2	-	-	-	-	-	-	-
9	1	28	-	-	4	2	-	-	1	-	4	-	-	3	-	-	-
10	1	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
11	5	8	-	-	-	5	-	-	-	1	2	-	-	-	-	-	-
12	-	66	-	-	-	3	-	-	-	3	-	-	-	-	-	-	-
13	1	10	-	-	-	-	-	-	2	1	2	-	-	-	-	-	-
14	4	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-
15	2	28	-	-	2	-	-	-	2	1	-	-	-	-	-	-	-
16	4	9	50	-	-	-	-	-	1	-	-	-	-	-	-	-	-
17	1	10	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-
18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	-	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-	-
20	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-

Sighting Totals

EleM	EleF	Buff	Zeb	Imp	Kudu	EIC2	EIC3	EIC4	UnCa	Grf	Whog	Dkr	Ghb	Rhin	Bbk	BRh
30	287	53	35	132	23	2	2	19	17	16	8	4	5	3	3	1

Date of Survey : 09/11/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 910 km²
 N : 169 n : 9
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Tsholotsho East
 Base Line Length : 56.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.306
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleF	Kudu	EIC4	UnCa	Catt	Shoa	Donk
1	-	-	-	-	-	-	-
2	-	-	1	1	24	-	-
3	-	-	-	-	7	-	-
4	-	-	-	-	1	1	2
5	-	-	1	-	6	-	-
6	34	-	-	1	17	-	-
7	-	1	-	-	-	-	-
8	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-

Sighting Totals

EleF	Kudu	EIC4	UnCa	Catt	Shoa	Donk
34	1	2	2	55	1	2

Date of Survey : 09/11/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 474 km²
 N : 218 n : 8
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Tsholotsho FarNorth
 Base Line Length : 73.2 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.365
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EIC4	Catt	Shoa	Donk
1	-	-	-	-	-
2	-	-	4	12	3
3	-	1	-	-	-
4	-	1	6	-	-
5	5	1	-	-	-
6	-	-	17	-	5
7	-	-	46	13	1
8	-	-	-	-	-

Sighting Totals

	EleM	EIC4	Catt	Shoa	Donk
	5	3	73	25	9

Date of Survey : 27/10/07
 Stratum Locality : NW Matabeleland
 Stratum Area : 543 km²
 N : 95 n : 7
 Pilot : C Mackie
 Map overlay file : None

Stratum Name : Zambezi NP
 Base Line Length : 32 km
 Calibrated Strip Width at 300ft : 328 m
 t : 2.447
 Observer : G Mtare / C Zhuwau

Transect summary table :

T #	EleM	EleF	Buff	Sab	Zeb	Imp	Kudu	Hipo	EIC4	UnCa	Grf
1	-	-	-	-	-	-	-	1	-	-	-
2	6	-	50	1	-	-	-	-	3	-	-
3	1	17	16	12	-	-	-	9	2	1	-
4	-	-	-	1	15	-	-	-	2	1	-
5	-	-	4	1	-	-	1	-	1	-	5
6	2	-	12	6	-	9	-	-	3	1	4
7	1	-	-	-	-	-	-	1	-	1	-

Sighting Totals

	EleM	EleF	Buff	Sab	Zeb	Imp	Kudu	Hipo	EIC4	UnCa	Grf
	10	17	82	21	15	9	1	11	11	4	9

Appendix 5. Comparison of observers

Introduction

One of the observers in this survey (the left one) had no previous experience of observing during transect surveys. Hence, the numbers of groups and animals counted by the two observers were compared to determine if the observers appeared to be similarly efficient.

Methods

For each species, the total numbers of groups and of individual animals counted by each observer in all transects were determined. For each observer and each species, the numbers of groups and individual animals that the observer was expected to see (if the observers were equally efficient and the animals similarly distributed on the two sides of the aircraft) were calculated as follows.

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

where:

Expected Number = the number of groups/animals 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/animals 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 calibrated combined 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/animals 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.

Results

The right observer (who had previous survey experience) saw more groups of giraffe, steinbuck and waterbuck than the novice left observer (Table A5.1). However, when individual animals – as opposed to groups - were considered, the difference for giraffe was reduced, suggesting that for this species the group difference was at least partly due to differences between the two observers in their definition of a group.

This survey was designed to count elephants and so particular attention was paid to the observers' observations of these. The numbers of cow herds and cows counted by the two observers were very similar to those expected if the observers were equally efficient (once allowance was made – as it was in Table A5.1 - for the differing widths of the left and right strips). However, the novice left observer saw more elephant bull groups and more elephant bulls than expected and while the results are not of great statistical significance, it is surprising that a novice observer should see more than an observer with some experience.

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

The left observer had no prior experience as a transect survey observer. The strip width when flying at 300 feet above ground level was 174 m for the left observer and 153 m for the right observer. No chi-square test was conducted if any expected number was < 5. P indicates the probability of the observed numbers if there was no difference in the efficiency of the two observers. ns = not significant.

Species	Observed Number of Groups		Expected Number of Groups		Observed Number of individuals		Expected Number of individuals		Chi-square (groups)	P	Chi-square (individuals)	P
	Left	Right	Left	Right	Left	Right	Left	Right				
Buffalo	19	20	21	18	643	818	777	684	0.4	0.521	49.4	0.000
Carcass 1 or 2	7	12	10	9	7	12	10	9	1.9	0.168	1.9	0.168
Carcass 3	3	9	6	6	3	10	7	6	3.0	0.083	5.0	0.026
Carcass 4	120	88	111	97	123	88	112	99	1.6	0.211	2.3	0.129
Cattle	18	21	21	18	118	142	138	122	0.9	0.335	6.2	0.013
Donkey	4	2	3	3	8	4	6	6			1.3	0.248
Duiker	12	7	10	9	14	7	11	10	0.8	0.358	1.7	0.190
Eland	2	5	4	3	2	8	5	5			3.6	0.058
Elephant bull	269	203	251	221	465	352	435	382	2.8	0.097	4.4	0.035
Elephant cow	190	173	193	170	1484	1284	1473	1295	0.1	0.752	0.2	0.675
Giraffe	23	45	36	32	59	71	69	61	10.0	0.002	3.1	0.079
Ground hornbill	6	4	5	5	14	12	14	12	0.4	0.527	0.0	1.000
Hippo	4	1	3	2	1	12	7	6			11.1	0.001
Impala	29	26	29	26	245	227	251	221	0.0	1.000	0.3	0.580
Kudu	14	21	19	16	40	65	56	49	2.9	0.090	9.8	0.002
Ostrich	7	2	5	4	12	4	9	7			2.3	0.131
Roan	3	6	5	4	5	16	11	10			6.9	0.009
Sable	25	30	29	26	110	202	166	146	1.2	0.280	40.4	0.000
Steinbuck	1	10	6	5	1	11	6	6	9.2	0.002	8.3	0.004
Unknown Carcass	62	67	69	60	65	68	71	62	1.5	0.217	1.1	0.297
Warthog	9	14	12	11	18	24	22	20	1.6	0.210	1.5	0.217
Waterbuck	3	10	7	6	38	69	57	50	5.0	0.026	13.6	0.000
Wildebeest	9	2	6	5	140	10	80	70	3.3	0.069	96.4	0.000
Zebra	29	32	32	29	160	189	186	163	0.6	0.442	7.8	0.005

During this survey, there were two calibration exercises (Appendix 1). On both occasions, the actual strip width of the novice left observer was positively correlated with flying height (as it should have been). For the left observer, the calibrated strip width at 300 feet agl was 176 m during the first exercise and 174 m during the second. For any observer, such results would be considered very encouraging. They suggest that the left observer was using the rods and decision and window marks correctly during the calibration exercises.

Conclusion

The differences between the two observers in the numbers of bull groups and bulls seen may be due to chance (after all, the animals being counted during a survey are seldom equally distributed on the two sides of the plane). Or the left observer may have been less effective at using the rods and decision and window marks during the actual survey than during the calibrations, with the result that some bull groups near the edge of the search strip were considered to be inside the strip when in fact they were outside.

The need for extensive and rigorous training of observers prior to their involvement in major (and therefore expensive) surveys cannot be emphasised too strongly.

Reference

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