

National Summary of Aerial Survey Results for
Elephant in Zimbabwe: 2014

Kevin M. Dunham

October 2015



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

The 2014 elephant surveys were conducted in partnership with the Zimbabwe Parks and Wild Life Management Authority

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



An earlier version of this report, dated June 2015, was produced by the Parks and Wild Life Management Authority, Zimbabwe.

The contents of the June 2015 report and this current version are identical.

Summary

The principal populations of elephants in Zimbabwe were surveyed from the air during the period June to November 2014. These populations are located in north-west Matabeleland, the Sebungwe region, the unflooded Middle Zambezi Valley and the south-east lowveld. The total area surveyed was 66324 km². This was the first time since 2001 that all these populations were studied during the same year. The surveys were sample counts and the methods followed those used during previous surveys.

There were estimated to be 82092 elephants (+/- 95 % confidence interval 10.5 %, or 8650 elephants) in the regions surveyed from the air. The lower and upper confidence limits of this mean estimate were 73442 and 90742 elephants.

There are known to be several small sub-populations of elephants occurring outside these survey areas, and estimates or 'guesstimates' of the numbers of animals in these sub-populations were obtained from people familiar with them. Elephants occurred at 16 locations outside the survey regions and the total number of elephants in these sub-populations was approximately 2420.

Thus, there were estimated to be, in total, 84512 elephants in Zimbabwe during the 2014 dry season. It is more practical to take account of the confidence limits for the estimate from the air surveys and state that there were between about 76000 and 93000 elephants in Zimbabwe during the 2014 dry season. Approximately 88 % of these were in the Parks & Wild Life Estate and about 54 % were in Hwange National Park.

In the regions surveyed from the air, there were, in total, an estimated 55 'fresh' carcasses of elephants, 226 'recent' carcasses and 6570 'old' and 'very old' carcasses. Overall, these carcasses formed 7.7 % of all elephants (live and dead) estimated to be in these regions. The all-carcass "ratio" varied from 4.1 % in the Save Valley Conservancy to 30.2 % in the Sebungwe. The 1+2 carcass "ratio" varied from 0 % in Gonarezhou and the Save Valley Conservancy to 2.17 % in the Sebungwe.

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Introduction

In order to assess the status of the elephant population in Zimbabwe, sample aerial surveys of the principal sub-populations were conducted during the 2014 dry season. This was the first time since 2001 that all principal sub-populations were surveyed during the same year. The methods used closely followed those utilised during the 2001, so that the results of the 2014 surveys are comparable with those from previous surveys.

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

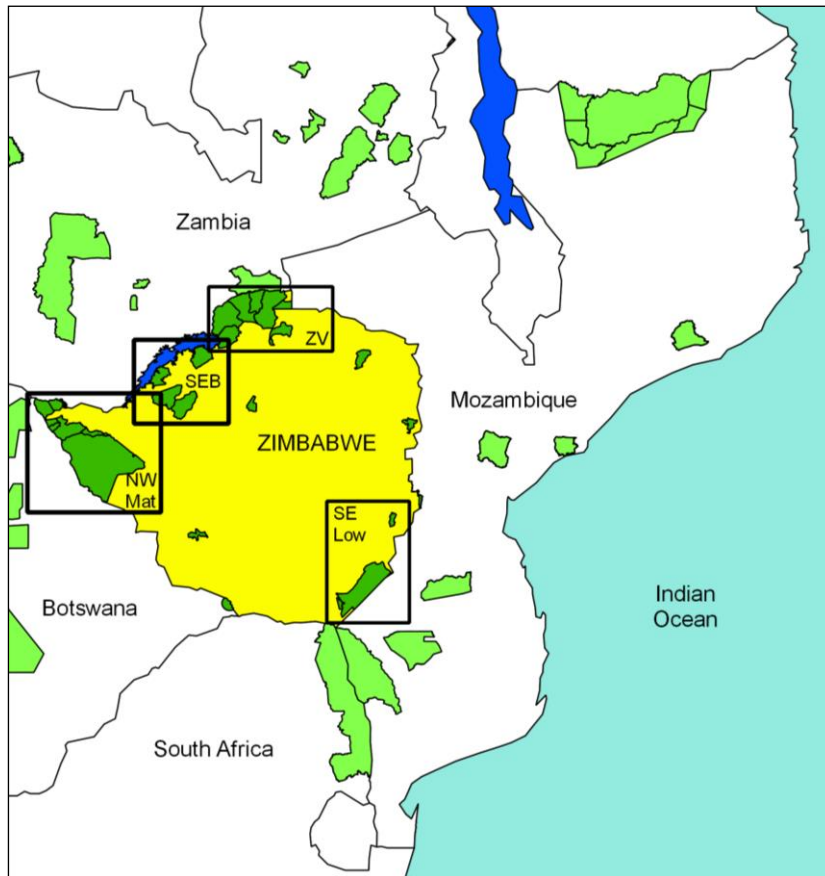
There are known to be several sub-populations of elephant outside the regions surveyed from the air. But there are relatively few elephants in these sub-populations and so it would not have been cost-effective to include them in the air survey programme. Nevertheless, an attempt is made here to consider these small sub-populations when deriving an estimate of the total number of elephants in Zimbabwe.

Methods

Aerial Surveys

Survey Area

Elephant populations were surveyed from the air in four regions of Zimbabwe, namely north-west Matabeleland, the south-east Lowveld (Gonarezhou National Park and Save Valley Conservancy), the Sebungwe, and the unflooded Middle Zambezi Valley. The procedures used followed those well established for aerial surveys of African large herbivores (Norton Griffiths 1978) and utilised during earlier surveys of elephants in Zimbabwe. Detailed reports of the 2014 surveys are provided by Dunham, Mackie & Nyaguse (2015), Dunham, Mackie, Nyaguse & Zhuwau (2015a, b) and Dunham & van der Westhuizen (2015). The entire survey area covered 66324 km² and was divided into 88 strata (subdivisions) (Table 1). Strata boundaries were drawn so that elephant density within a stratum was spatially uniform, and the boundaries were essentially the same as those used during the 2001 surveys.



Map 1. The location of the aerial survey areas in Zimbabwe

National Parks and Safari Areas in Zimbabwe are shown in dark green and selected protected areas in neighbouring countries are shown in light green. The boxes highlight the survey areas, which are shown in more detail in the following maps: NW Mat, North-west Matabeleland; SEB, Sebungwe; SE Low, South-east Lowveld; ZV, Zambezi Valley.

Transect surveys

Regularly-spaced, parallel transects (flight lines) were positioned across each stratum in areas of generally flattish ground. These areas included all of the north-west Matabeleland, Gonarezhou and Save Valley Conservancy (SVC), the Zambezi Valley floor and all of the Sebungwe except for the hills of Matusadona NP and Kanyati. Transect surveys were flown during the period 21 August – 1 November 2014.

Transects were arranged at right angles to the principal environmental feature within a stratum – for example, transects crossed major river systems. Within most strata, transect orientation was the same as that used during the 2001 survey. Sampling intensity (i.e. the percentage of the study area that was actually surveyed) varied between regions and, in each region, except SVC, was similar to that used during the 2001 surveys. The distance between adjacent transects varied between strata, according to the planned sampling intensity in each stratum. The latter was determined by predicting that the elephant density in each stratum would be similar to that observed during the most recent previous surveys (see Gibson (1989) for method). As a consequence, those strata expected to contain large numbers of elephants were sampled more intensively (i.e. transects were closer together) than strata expected to contain few elephants. Transect spacing generally varied from 1.5 km in strata expected to contain many elephants, to 10 km in strata expected to contain few.

Surveys were designed using software that was custom-written by WWF-SAPRO for this purpose. Given the latitude/longitude co-ordinates that describe a stratum boundary, the transect orientation, the transect spacing and a random number, this software generates transects (flight lines), with the first transect offset from the end of the stratum by the random distance. The start and end points for each transect were transferred as waypoints to a GPS receiver in the aircraft (a Cessna 206) prior to flying each stratum. During surveys, the plane was flown at approximately 170 km per hour at about 300 feet above ground level (agl).

The aircraft crew consisted of four people, who could talk to one another through an intercom system. The crew were:

- the pilot, who was responsible for:
 - flying the plane safely;
 - navigating along the transects (by reference to the aircraft's GPS receiver); and
 - maintaining the required height above the ground (by reference to the display for a downward-pointing laser rangefinder attached to a wing strut).
- the recorder, who sat next to the pilot and was responsible for:
 - recording the actual height of the aircraft every 30 seconds while flying along transects (from the rangefinder display);
 - recording the time taken to fly each transect (using a stopwatch);
 - recording the number of elephants seen by observers and, for each group, its GPS location and the time since the start of the transect; and
 - monitoring adherence to the intended route, ground speed, and height about ground level (by reference to a separate GPS receiver and the laser rangefinder display).
- two experienced observers, who sat behind the pilot and recorder. The observers were responsible for:
 - looking for elephants and carcasses, and counting those seen within the counting strips;
 - calling all sightings of these to the recorder;
 - differentiating groups of elephant bulls from cow herds (although the latter may have included some bulls); and
 - classifying the age since death for elephant carcasses (see Table 2 for details).

On each side of the plane, a counting strip was defined by two fibreglass rods that were attached to the wing strut, 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, the distance represented a strip about 150 m wide on the ground. Each rod was marked with a small piece of tape to provide the observers with a "decision point" (at this point the observer decided whether an animal was in or out of the strip). For each regional survey, the strip widths were calibrated by flying the aircraft at right angles across an airstrip that had large-sized numbers arranged at 10 meter intervals along the side of the airstrip. Each observer noted the largest and smallest number within his strip and the recorder noted the aircraft's height. The nominal combined strip width at 300 feet agl was determined by averaging the combined strip widths, after adjusting these to 300 feet agl.

The observers were tested: to ensure that they were not colour-blind; to check their visual acuity, and to determine their ability to estimate group sizes with reasonable accuracy.

Block counts

In hilly areas (the Chewore Hills and the hills south of the Zambezi escarpment, stretching from Matusadona NP in the west to Mavuradonha Wilderness Area in the east), block counts were used to count elephants. Blocks of land were defined on 1:50000 scale maps using features, such as drainage lines or watersheds, that would be recognisable from the air. The area of these blocks was usually 5-25 km². Blocks to be counted were selected with a probability proportional to their area (by using random numbers as map co-ordinates). Consequently, large blocks were more likely to be selected for counting than small blocks.

A pilot and one observer/recorder in a Piper Super Cub aircraft searched each block until it was believed that all elephants within it were seen. The recorder noted the number of elephants and elephant carcasses, and the time taken to search each block. Block counts were flown during the period 27 June – 14 July 2014.

Data analysis

For strata surveyed with transects, the estimated number of elephants (and carcasses) in a stratum and the confidence intervals of the estimates were calculated using method 2 of Jolly (1969)). The actual combined strip width for each transect was determined from the mean flying height for that transect and the nominal combined strip width at 300 feet agl. Transect area was the product of the actual combined strip width and transect length. The mean density of elephants in a stratum was calculated from the numbers of elephants seen within strips and the transect areas. The population estimate was the product of the mean density and the stratum area. For strata surveyed with block counts, population estimates and confidence intervals were calculated similarly (using method 3 of Jolly (1969)).

Population estimates for the entire study area, the survey regions within it and for various administrative units within those regions were calculated as the sum of the estimates for the individual strata within each land unit. The 95 % confidence interval (CI) of the population estimate for any land unit that comprised more than one stratum was calculated using the method of Gasaway *et al.* (1986). From the confidence *interval*, lower and upper 95 % confidence *limits* to the population estimate were calculated. The 95 % confidence limits can be interpreted to indicate that: there is a 95 % certainty that the true number of elephants lies between the lower and upper limits; or that there is just one chance in twenty that the true number of elephants lies outside the range defined by the lower and upper limits.

Strata boundaries did not always coincide with the boundaries of administrative areas and some compromises have been made during this part of the analysis. For example, in the tables that accompany this report, 'Hwange National Park' includes Deka Safari Area, and the Dande stratum includes Dande Safari Area and some communal land: in this analysis, it is included within Guruve Communal Area, because safari hunting rights in Dande SA are leased to Guruve Rural District Council.

Search intensity (in minutes per square kilometre) for a stratum was calculated as the total time spent flying all transects (or blocks) within that stratum, divided by the total area of those transects (or blocks). The greater the search intensity, the less the probability that observers did not observe animals that were within the strips. No corrections have been applied to any of the estimates to compensate for any undercounting or missed animals.

Elephant carcasses

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

here are directly comparable with the ratios and densities from the 2001 survey of this region.

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

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

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

Small Populations

Biologists, managers, owners and/or safari operators working in areas occupied by the small populations of elephants not surveyed from the air were asked to provide their assessment of the status of the elephant population during the 2014 dry season. The assessment included: an estimate of the number of elephants; any information to support the estimate (for example, sightings or survey data); the composition of the population (for example, bulls, cow herds, or both); and the elephants' distributional range and/or seasonal movements. Captive elephants were excluded from this assessment.

Table 1. Summary of sampling statistics for the 2014 aerial surveys

Region	Area (km ²)	Percent of area sampled	Dates sampled	Number of strata			Mean search intensity (minutes km ⁻²)
				Transect surveys	Block counts	Total	
Save Valley Conservancy	3496	7.6	31 October – 1 November	4	0	4	1.10
Gonarezhou	5339	11.6	26–30 October	9	0	9	1.18
North-west Matabeleland	24959	7.1	7 – 23 October	23	0	23	1.14
Zambezi Valley	17003	12.6	27 June – 31 August	14	12	26	1.14
Sebungwe	15527	12.9	12 July – 28 September	24	2	26	1.13
Totals	66324 km²			74	14	88	-

Table 2. Definitions of categories used to record time since death for elephant carcasses

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

These carcass categories differ from those used the 2001 surveys, when only three categories were used. These new categories are those now recommended by MIKE (a CITES programme, Monitoring the Illegal Killing of Elephants) (Craig 2012). 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.

Results

Small Populations

Outside the regions surveyed from the air, there were estimated to be approximately 1150 elephants at six locations for which population estimates were based on total-area aerial surveys, or waterholes counts (Table 3). There were another ten locations for which survey information was lacking and the estimated elephant number at these was sometimes based on a manager's considered assessment and other times (probably) a guess. There might be another 1270 elephants in these areas. Thus, there were, in total, approximately 2420 elephants in the locations not covered by the air sample surveys.

Aerial Surveys

Summaries of the results of the aerial surveys are given in Tables 5-21, which provide estimates of the numbers of elephants, bulls, elephants in cow herds and elephant carcasses in each region (Tables 5-12) and in each administrative area (Tables 14-21). The major findings of the study are presented below and in Table 4. Detailed results are contained in the separate survey reports.

North-west Matabeleland

The largest population of elephants in Zimbabwe was in north-west Matabeleland, where there were an estimated 53991 elephants (+/- CI 7711). Most (85 %) of these were in Hwange NP (Map 2), which contained an estimated 45846 (+/- CI 6316) elephants. This number represented more than 50 % of Zimbabwe's elephant population. Not only was the number of elephants in the national park very large, but the density of elephants, which averaged 3.0 elephants km⁻², was greater here than in any other protected area in Zimbabwe. The elephants in north-west Matabeleland form part of a larger population that Zimbabwe shares with northern Botswana.

Zambezi Valley

There were an estimated 11657 elephants (+/- CI 2259) in the Zambezi Valley survey region, which stretched from Kariba dam eastwards to the Mavuradonha hills (Map 3). This total included 2984 elephants (+/- CI 901) in Mana Pools NP and another 1904 (+/- CI 1469) in the communal areas (including Dande Safari Area). The elephants in the Zambezi Valley survey region form part of a larger population that Zimbabwe shares with the Lower Zambezi NP in Zambia and the Magoe district of Mozambique.

Sebungwe

There were estimated to be 3407 elephants (+/- CI 1214) in the Sebungwe region, south of Lake Kariba (Map 4). This total included 1200 (+/- CI 790) in Chirisa SA and just 497 elephants (+/- CI 412) in the Kariba, Binga and north Gokwe communal areas. Unlike the other elephant populations in Zimbabwe, the Sebungwe population is largely closed, being isolated by Lake Kariba, human settlement, and areas of communal and commercial agriculture. The elephants in the Sebungwe formed just 4 % of Zimbabwe's total elephant population (Table 4).

South-east Lowveld

There were estimated to be 11452 elephants (+/- CI 2788) in the Gonarezhou area and 1585 elephants (+/- CI 1346) in the Save Valley Conservancy (Map 5). Together with 291 elephants in Malilangwe Wildlife Estate, an estimated 55 in Chiredzi River Conservancy and an estimated 54 on Nuanetsi Ranch, these form the south-east lowveld population. But most (83 %) of the elephants in this region were in Gonarezhou NP, where the population was estimated to be 11120 (+/- CI 2753) elephants. The eastern boundary of this national park is the international border with Mozambique and elephants in Gonarezhou NP are free to cross it.

Zimbabwe

There were estimated to be a total of 82092 (+/- CI 8650) elephants in the aerial survey regions, plus approximately 2420 elephants outside these. Thus, during the 2014 dry season, there were estimated to be between c.76000 and c.93000 elephants in Zimbabwe. Approximately 88 % of these were in the Parks and Wild Life Estate (Map 6).

Elephant Carcasses

The all-carcass "ratio" (when averaged across each aerial survey region) was in the range 4.1 – 7.0 % in all regions except the Sebungwe, where it was 30 %. A ratio of 2-8 % is usually taken as indicative of a stable or increasing population number, while a ratio greater than 8 % is indicative of a declining population number (Douglas-Hamilton *et al.* 1992). For all the aerial survey regions combined, the carcass ratio was close to 8 % (Table 12).

At a national level, relatively few fresh or recent carcasses were seen (Tables 8 & 9), but the 1+2 carcass ratio was high in the Sebungwe (Table 12).

Table 3. Status of small populations of elephants during the dry season of 2014

Location (see Map 6)	Number of elephants				Composition	Authority	Notes
	Definite	Probable	Possible	Speculative			
Shangani	174				Bulls	C. Edwards	174 bulls seen during total area survey of Shangani Ranch by helicopter during July 2014
Malilangwe Estate & Hippo Valley Estates Game Section	291				132 in cow herds & 159 in bull groups	B. Clegg	291 elephants seen during a total-area survey by helicopter during September/October 2014
Chiredzi River Conservancy		55			Bulls & cows	T. Warth	<ol style="list-style-type: none"> 1. All but two cows from the 25 elephants released during 1992 have been killed or have disappeared. 2. All other elephants born since 1998. 3. Three young bulls tend to spend time away from the cow herds, but are seen with them frequently. 4. Two groups, one of 11 young cows with subadults and their first calves.
Tuli Safari Area and Sentinel, Nottingham & River Ranches	212				Tuli SA – several bull groups & herd of 30 elephants Nottingham Estate – group of 78 elephants	Selier & Page (2015)	Total-area survey by fixed-wing aircraft during August 2014, with flight lines 800 m apart. Saw 154 elephants (mean density 0.20 km ⁻²) on Sentinel & Nottingham Ranches and 58 elephants (0.12 km ⁻²) in Tuli Safari Area. Part of a population which, during August 2014, numbered at least 1449 animals and was centred on Botswana's Northern Tuli Game Reserve.

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Location (see Map 6)	Number of elephants				Composition	Authority	Notes
	Definite	Probable	Possible	Speculative			
Bubye Valley Conservancy				500 - 600	Bulls & cow herds	K. Leathem, N. English	<p>When BVC acquired Samanyanga property during 2002, there were approximately 50 elephants, from an original purchase of 32 during 1997 (from a ranch in the Mateke Hills), plus a few bulls that had broken in from the communal lands to the south.</p> <p>During July 2006, BVC received 25 elephants removed from Makambe and Ursula farms near Victoria Falls (17 cows/calves and 8 adult bulls).</p> <p>During October 2008, BVC received 56 elephants from Malilangwe (cows/calves, plus a few young bulls that were still in the breeding herds).</p> <p>During November 2013, BVC translocated 80 elephants from the Ripple Creek property into the main conservancy (all had moved onto Ripple Creek from Bubiana).</p> <p>Each year, a few elephants break into BVC from the adjacent communal lands and resettlement areas. Usually an estimated 5–15 young bulls, but on one occasion a herd of 22 cows and calves.</p>
Mangwe Dam		20		40	Bulls	G. & D. Robertson, G. Winch	<p>Herd of about 20 bulls seen and photographed in vicinity of Mangwe Dam on 5 October 2014. Unverified report of a second herd of up to 40 elephants.</p>

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Location (see Map 6)	Number of elephants				Composition	Authority	Notes
	Definite	Probable	Possible	Speculative			
Nuanetsi Ranch		54			Bulls & cow herds	B. Lees May	39 cows and calves translocated from Buby Valley Conservancy during August 2012. Since then, approximately 15 bulls moved onto Nuanetsi. Contained within a 1489 km ² area surrounded by an electrified fence.
Nyatana Wildlife Management Area				30	?	E. Madzivanyika	Elephants reported to move between this area and Mozambique.
Stanley & Livingstone Game Reserve (Nakavango)				36	Bulls & cow herds	I. DuPreez	
Fuller Forest Land		308			?	M. Sebele	Estimate from 24-hour waterhole count
Gwaai/Bembesi/Umguza Forest Lands		165			?	M. Sebele P. Johnstone	Estimate from 24-hour waterhole count
Gwampa/Lake Alice Forest Lands				150	?	M. Sebele	Reported by wildlife scouts
Bubiana				100	Bulls & cow herds	D. Drummond	Approximately 100 elephants on Rocky Glen, moving onto Swallowford and Crystal Springs ranches.
Hartley Safari Area				150	?	C. Mwale	
Kavira Forest Land				70-100	Cow herds	M. Sebele	Four cow herds seen by wildlife scouts

Table 4. Summary of the population estimates for elephants in Zimbabwe during 2014

Area or Land Use Category	Population estimate for:		Population estimate as percentage of regional population estimate	Population estimate as percentage of national population estimate
	NP / SA	Land use Region category		
North-west Matabeleland				
Hwange NP	45846		84.4	54.2
Zambezi NP	52		0.1	0.1
Matetsi / Kazuma / Panda Masuie	4791		8.8	5.7
<i>Parks & Wild Life Estate</i>		50689	93.3	60.0
<i>Communal Areas</i>		2201	4.1	2.6
<i>Forest Areas / Private Land</i>		1445	2.7	1.7
NW Matabeleland region		54335	100.0	64.3
Zambezi Valley				
Mana Pools NP	2984		25.6	3.5
Safari Areas	6768		58.1	8.0
<i>Parks & Wild Life Estate</i>		9753	83.7	11.5
<i>Communal Areas / Mavuradonha WA</i>		1904	16.3	2.3
Zambezi Valley region		11657	100.0	13.8
Sebungwe				
Chizarira NP	747		21.9	0.9
Matusadona NP	669		19.6	0.8
Safari Areas	1478		43.4	1.7
<i>Parks & Wild Life Estate</i>		2894	84.9	3.4
<i>Communal Areas</i>		497	14.6	0.6
<i>Forest Area</i>		16	0.5	0.02
Sebungwe region		3407	100.0	4.0

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Area or Land Use Category	Population estimate for:		Population estimate as percentage of regional population estimate	Population estimate as percentage of national population estimate
	NP / SA	Land use category		
South-east Lowveld				
Gonarezhou NP	11120		82.8	13.2
Malapati SA	0		0	0
<i>Parks & Wild Life Estate</i>		11120	82.8	13.2
<i>Save Valley Conservancy</i>		1585	11.8	1.9
<i>Malilangwe & Chiredzi R. Conserv.</i>		346	2.6	0.4
<i>Nuanetsi Ranch</i>		54	0.4	0.1
<i>Communal Area</i>		332	2.5	0.4
South-east Lowveld region		13437	100.0	15.9
Other locations				
Hartley SA	150		8.9	0.2
Tuli SA	58		3.5	0.1
<i>Parks & Wild Life Estate</i>		208	12.4	0.2
<i>Other</i>		1468	87.6	1.7
Other locations		1676	100.0	2.0
Total for Parks & Wild Life Estate	74663			88.3%
Total Population Estimate for Zimbabwe		84512		

Note: There may appear to be small arithmetical errors in this table – these are simply rounding errors

Changes since 2001

Detailed comparisons between regional estimates for 2001 and those for 2014 - including the outcomes of appropriate statistical tests - are contained in the separate survey reports (Dunham *et al.* 2015a,b,c, Dunham & van der Westhuizen 2015). The outcomes of statistical tests comparing the combined (i.e. for all survey regions) estimates for 2001 with those for 2014 are given in Table 13. A population estimate is considered to have changed since 2001 only if the difference between the 2001 and 2014 estimates is statistically significant.

North-west Matabeleland

The number of elephants in north-west Matabeleland during 2014 did not differ (at least in terms of statistical significance) from the number there during 2001. Similarly, there was no change in the number of elephants in Hwange NP. However, the number of elephant bulls in bull groups did decline between 2001 and 2014, decreasing by 21 % in Hwange NP, by 77 % in the Matetsi complex, and by 27 % in north-west Matabeleland overall.

Between 2001 and 2014, the number of all elephant carcasses increased by 251 % in Hwange NP, and by 148 % in north-west Matabeleland as a whole.

Zambezi Valley

The number of elephants in the Zambezi Valley declined by 40 % between 2001 and 2014. The number of elephants in cow herds decreased by 47 % during this period, but the number of elephants in bull groups did not change. There was also no change in the number of all elephant carcasses.

The decline in the number of elephants without any increase in the number of carcasses is surprising and contrasts with the situation in the Sebungwe (see below), where a decrease in the number of elephants was accompanied by an increase in the number of carcasses.

Sebungwe

The number of elephants in the Sebungwe had declined by 76 % since 2001. The number of elephant bulls and the number of elephants in cow herds showed similar declines (71 and 77 % respectively), while the number of all elephant carcasses increased by 70 %.

South-east Lowveld

The number of elephants in Gonarezhou NP had increased by 123 % since 2001. Since the 1992 drought and the 1993 elephant captures, the number of elephants in Gonarezhou NP has increased at a mean rate of 6 % per annum.

Zimbabwe

The total number of elephants in all aerial survey regions of Zimbabwe combined had not changed since 2001, but the estimated number of elephant bulls in these regions had declined by 23 % (Table 13). The total numbers of 'fresh' and 'recent' carcasses were similar in the two years (272 during 2001 and 281 during 2014), but the estimated number of all elephant carcasses had doubled since 2001. Hence, the all-carcass ratio for Zimbabwe had also approximately doubled, increasing from 3.8 % during 2001 to 7.7 % during 2014.

Long-term Trend in the Number of Elephants in Zimbabwe

During the period 1980 to 1989, there were regular, large-scale culls of elephants in Zimbabwe (Booth *et al.* 1996). But despite these culls, the number of elephants in the country increased (Fig. 1). There was a severe drought during 1992, but following that (and in the absence of large-scale culls after 1993) the number of elephants in Zimbabwe increased further and at a greater rate than during the 1980s. From 1993 to 2001, the mean population growth rate of elephants in Zimbabwe was approximately 5 % per annum. The results of the 2014 surveys suggest that the Zimbabwe elephant population is no longer increasing in number.

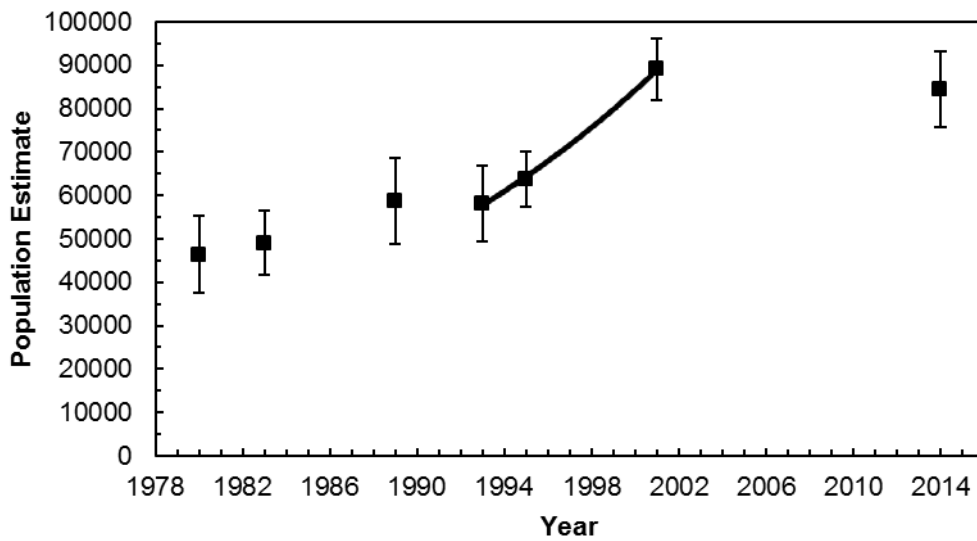


Fig. 1. Temporal changes in the estimated number of elephants in Zimbabwe since 1980

Mean population estimates and 95% confidence intervals shown. The bold line indicates the trend in the number of elephants in Zimbabwe from 1993 to 2001, during which period there were no large-scale culls. Data for 1980-1995 taken from the summary provided by Price Waterhouse (1996).

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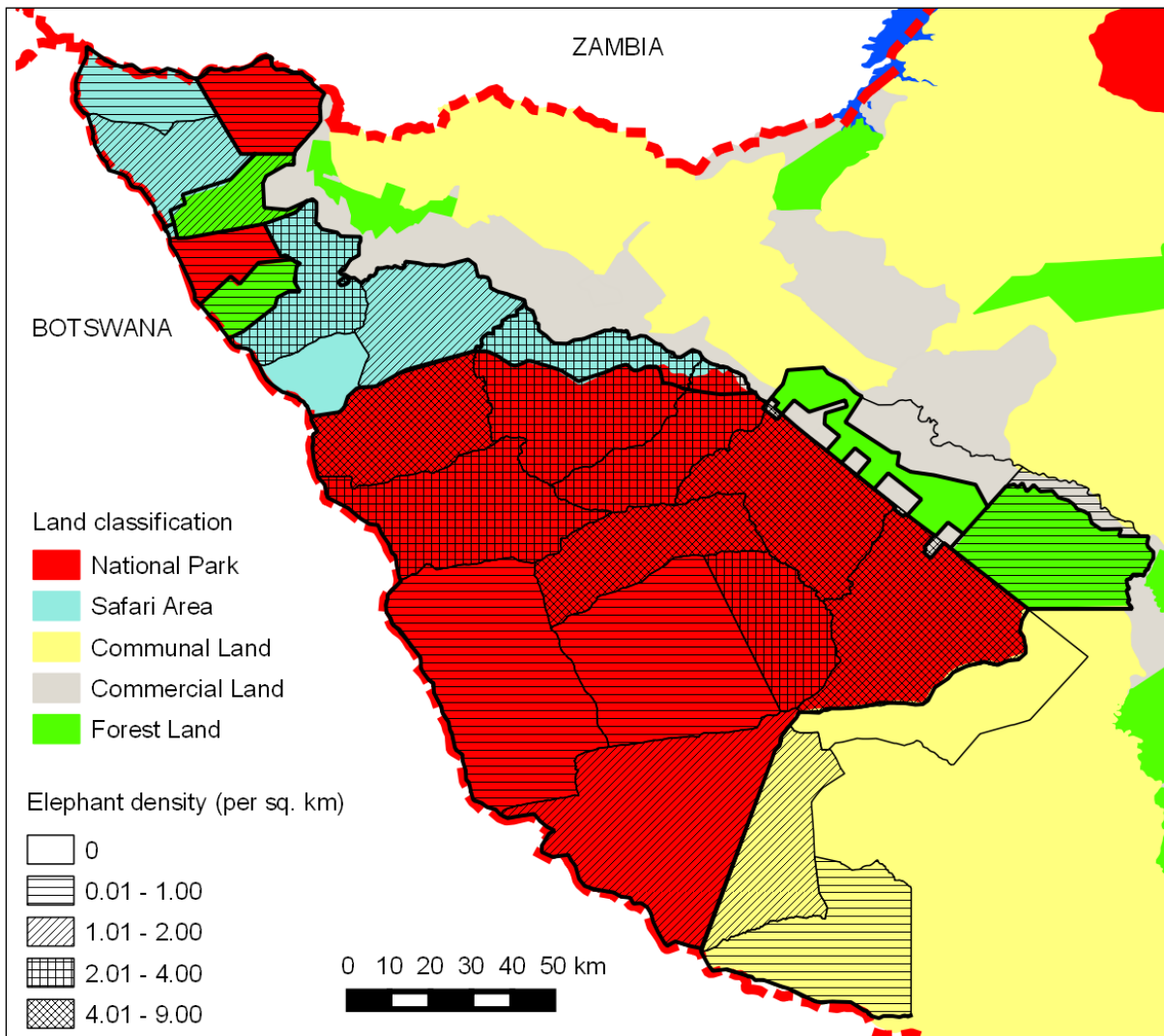
The survey planes were piloted by Mr Charles Mackie, Mr Martin Henriksen and Mr Hugo van der Westhuizen (FZS).

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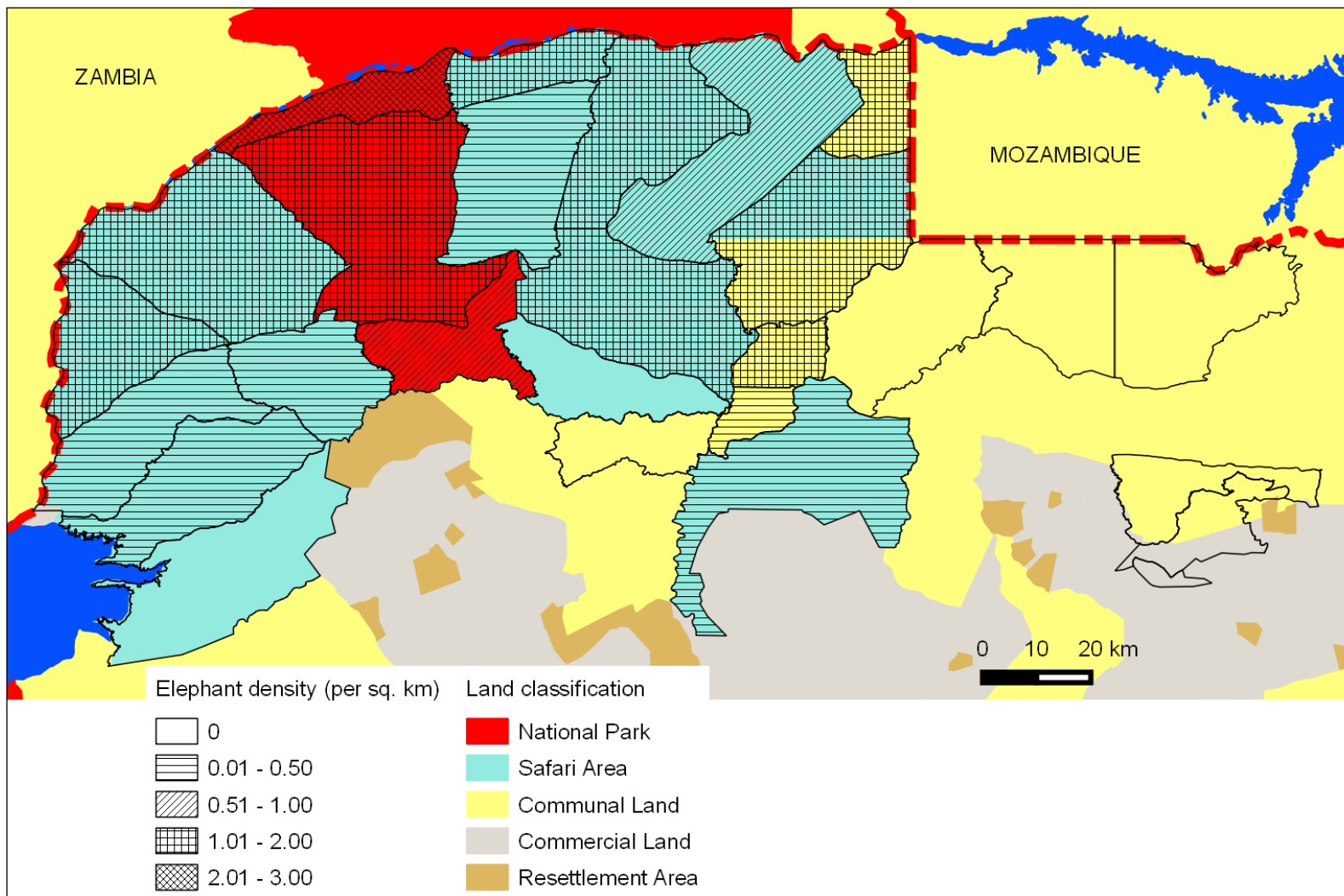
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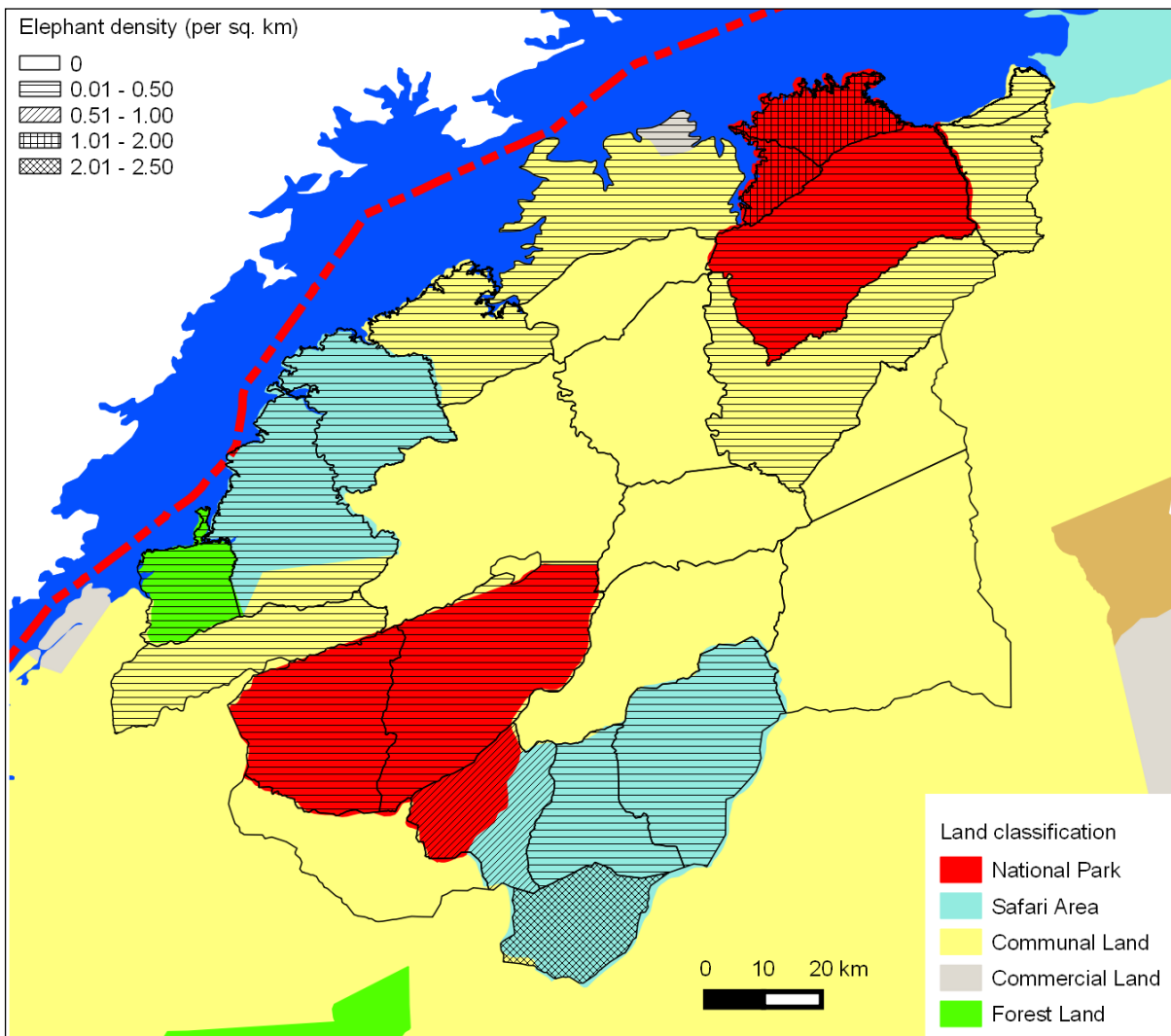
Map 2. The survey region in north-west Matabeleland of Zimbabwe.

Map shows (from north to south) Zambezi, Kazuma Pan and Hwange National Parks; the northern and southern sections of Matetsi Safari Area, and Deka Safari Area; and Panda Masuie, Kazuma, Sikumi and Ngamo Forest Areas. Elephant density during the 2014 dry season is indicated for individual survey strata.



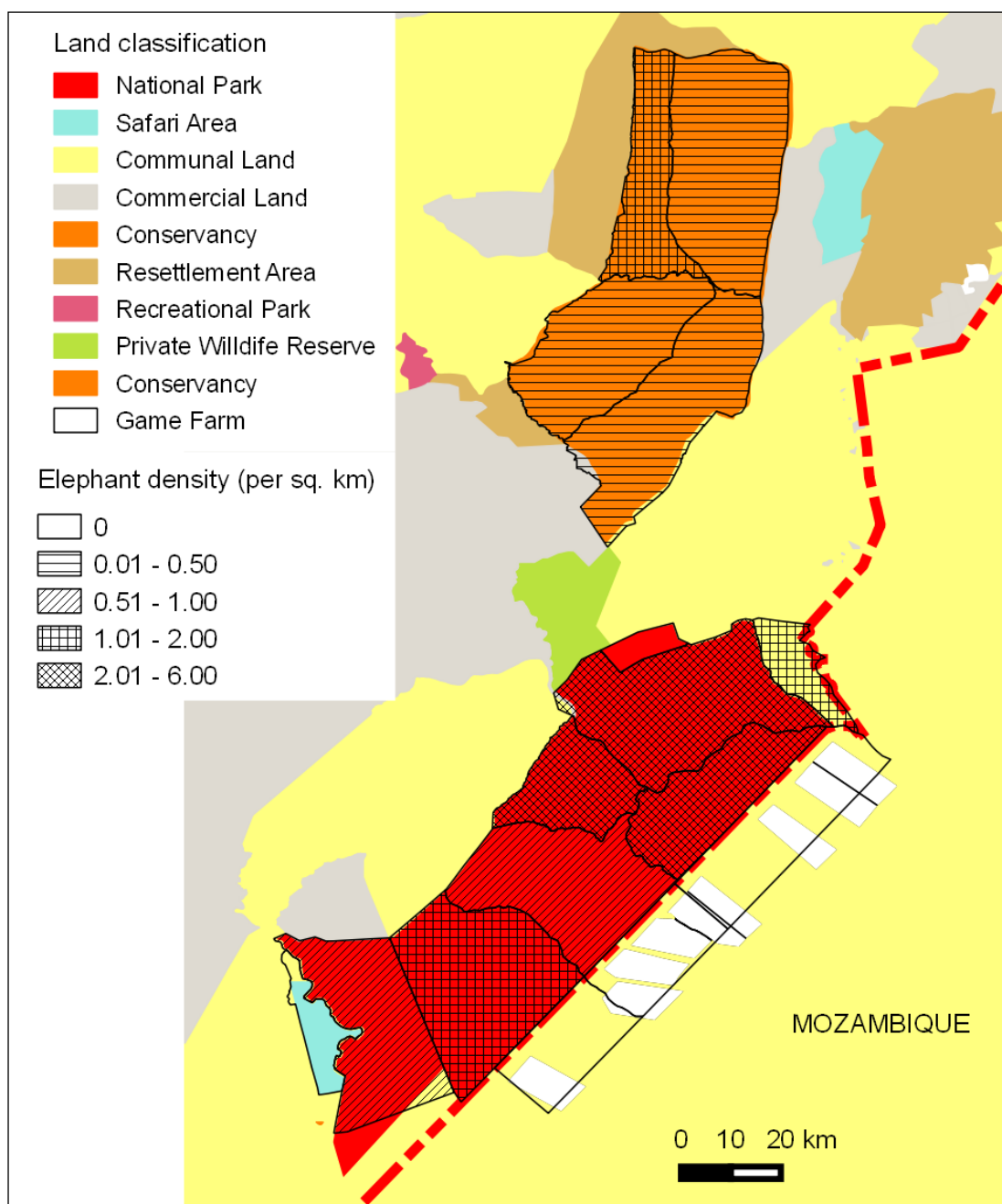
Map 3. The survey region in the unflooded Middle Zambezi Valley of northern Zimbabwe.

Map shows Mana Pools National Park, Mavuradonha Wilderness Area and (clockwise from south-west) Charara, Hurungwe, Sapi, Chewore, Dande and Doma Safari Areas. Elephant density during the 2014 dry season is indicated for individual survey strata.



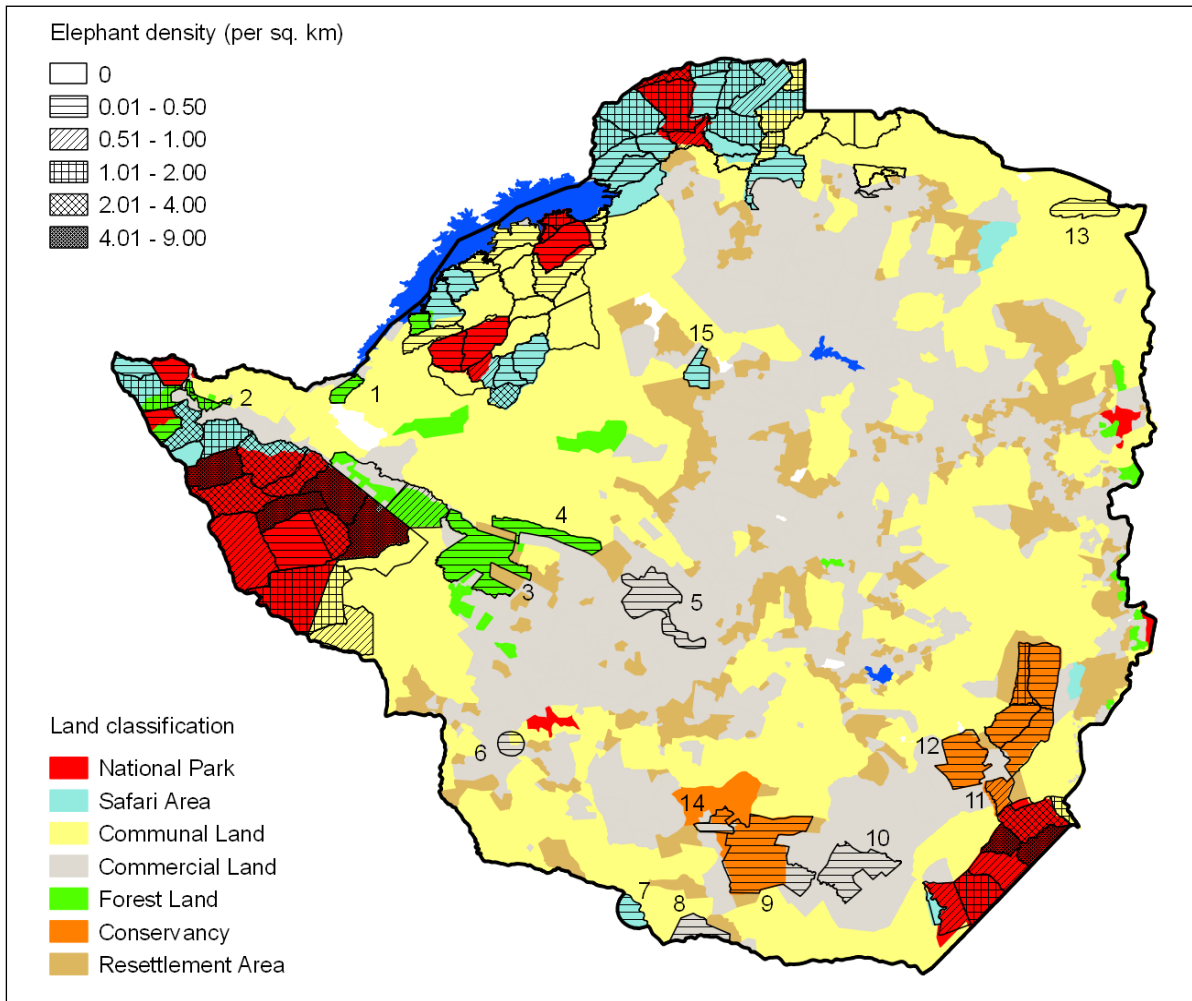
Map 4. The survey region in the Sebungwe area of north-west Zimbabwe.

Map shows (from north to south) Matusadona and Chizarira National Parks, Chete and Chirisa Safari Areas, and Sijarira Forest Area. Elephant density during the 2014 dry season is indicated for individual survey strata.



Map 5. The survey regions in the south-east lowveld of Zimbabwe.

Map shows Gonarezhou National Park, Malapati Safari Area and the Save Valley Conservancy. Elephant density during the 2014 dry season is indicated for individual survey strata.



Map 6. The density and distribution of elephants in Zimbabwe during the dry season of 2014, in relation to land classification.

Site 1, Kavira Forest Land; 2, Fuller Forest Land and Nakavango Ranch; 3, Gwaai, Bembesi and Umguza Forest Lands; 4, Gwampa and Lake Alice Forest Lands; 5, Shangani; 6, Mangwe Dam; 7, Tuli Safari Area; 8, Sentinel and Nottingham Ranches; 9, Buby Valley Conservancy; 10, Nuanetsi Ranch; 11, Malilangwe Wildlife Estate; 12, Chiredzi River Conservancy; 13, Nyatana Wildlife Management Area, 14, Bubiana, 15, Hartley Safari Area.

Appendix 1. Tables of population estimates and statistics for elephant, elephant bulls, elephants in cow herds, and elephant carcasses in Zimbabwe during 2014. Population estimates by region (Tables 5-12) and by administrative area (Tables 14-21). The statistical significance of changes in the estimates at the national level are given in Table 13.

Notes about Tables

Confidence intervals and confidence limits are 95 % confidence intervals and limits. “No. seen” is the number seen in the search strips or blocks during the surveys.

There may appear to be small arithmetical errors in the totals given in some tables. These are rounding errors: estimates, variances and sums were calculated with great precision before being rounded to the required number of decimal places.

Abbreviations are as follows:

Abbreviation	Meaning
CA	Communal Area
CI	Confidence Interval
CL	Confidence Limit
FA	Forest Area
NP	National Park
NW Mat	North-west Matabeleland
PWE	Parks & Wild Life Estate
SA	Safari Area
SVC	Save Valley Conservancy
WA	Wilderness Area
ZV	Zambezi Valley

Table 5. Population estimates and statistics for elephant in the aerial survey regions of Zimbabwe during 2014

Region	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Save Valley Conservancy	1585	118	436828	84.9	239	2931	0.45
Gonarezhou	11452	1571	1960565	24.3	8664	14240	2.14
NW Matabeleland	53991	4926	15140043	14.3	46280	61702	2.16
Zambezi Valley	11657	1094	1292716	19.4	9398	13915	0.69
Sebungwe	3407	583	372110	35.6	2193	4622	0.22
Totals	82092	8292	19202261	10.5	73442	90742	1.24

Table 6. Population estimates and statistics for elephant bulls in the aerial survey regions of Zimbabwe during 2014

Region	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Save Valley Conservancy	55	4	1825	166.3	4	147	0.02
Gonarezhou	1198	157	33604	30.9	828	1569	0.22
NW Matabeleland	6231	607	370290	19.4	5022	7439	0.25
Zambezi Valley	2560	239	144739	29.5	1804	3316	0.15
Sebungwe	776	115	30700	45.4	424	1129	0.05
Totals	10821	1122	581158	13.9	9317	12324	0.16

Table 7. Population estimates and statistics for elephants in cow herds in the aerial survey regions of Zimbabwe during 2014

Region	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Save Valley Conservancy	1529	114	435003	87.9	186	2873	0.44
Gonarezhou	10254	1414	1926961	27.0	7490	13018	1.92
NW Matabeleland	47761	4319	14769753	15.9	40143	55378	1.91
Zambezi Valley	9098	855	1147977	23.4	6965	11231	0.54
Sebungwe	2633	468	341410	44.3	1468	3799	0.17
Totals	71275	7170	18621103	12.0	62755	79795	1.07

Table 8. Population estimates and statistics for elephant carcass 1 in the aerial survey regions of Zimbabwe during 2014

Survey Region	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Save Valley Conservancy	0	0	0	0	0	0	0.00
Gonarezhou	0	0	0	0.0	0	0	0.00
NW Matabeleland	42	4	1111	165.2	4	112	0.002
Zambezi Valley	0	0	0	0.0	0	0	0.00
Sebungwe	12	2	69	141.1	2	29	0.001
Totals	55	6	1180	131.3	6	126	0.001

Table 9. Population estimates and statistics for elephant carcass 2 in the aerial survey regions of Zimbabwe during 2014

Survey Region	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Save Valley Conservancy	0	0	0	0.0	0	0	0.00
Gonarezhou	0	0	0	0.0	0	0	0.00
NW Matabeleland	149	9	2897	73.9	39	259	0.01
Zambezi Valley	13	1	182	236.5	1	45	0.001
Sebungwe	64	11	459	69.2	20	107	0.004
Totals	226	21	3537	53.1	106	346	0.003

Table 10. Population estimates and statistics for elephant carcass 3 in the aerial survey regions of Zimbabwe during 2014

Survey Region	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Save Valley Conservancy	27	2	337	140.3	2	65	0.01
Gonarezhou	90	10	759	62.3	34	146	0.02
NW Matabeleland	1001	80	24826	31.6	685	1318	0.04
Zambezi Valley	18	2	166	150.6	2	44	0.001
Sebungwe	259	41	2130	35.7	166	351	0.02
Totals	1395	135	28219	24.1	1059	1730	0.02

Table 11. Population estimates and statistics for elephant carcass 4 in the aerial survey regions of Zimbabwe during 2014

Survey Region	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Save Valley Conservancy	40	3	457	110.9	3	85	0.01
Gonarezhou	430	54	3879	28.8	307	554	0.08
NW Matabeleland	2871	245	46834	14.9	2443	3299	0.12
Zambezi Valley	693	55	9689	28.2	497	888	0.04
Sebungwe	1141	165	12811	19.7	916	1366	0.07
Totals	5175	522	73671	10.3	4641	5709	0.08

Table 12. Elephant carcass ratios in the aerial survey regions of Zimbabwe during 2014

Survey Region	1+2 carcass ratio (elephant carcasses in age category 1 or 2)	All-carcass ratio (all elephant carcasses)	All-carcass ratio (all elephant carcasses and unidentified carcasses)
Save Valley Conservancy	0.00	4.1	22.6
Gonarezhou	0.00	4.3	6.6
NW Matabeleland	0.35	7.0	8.2
Zambezi Valley	0.12	5.8	6.1
Sebungwe	2.17	30.2	38.9
All Regions Combined	0.34	7.7	9.9

Table 13. Statistical significance of changes in the estimated total numbers of elephants and elephant carcasses in all aerial survey regions combined in Zimbabwe during 2014

Species / observation	2001		2014		Difference		Change (%)
	Estimate	% CI	Estimate	% CI	t'	P	
Elephant	88123	8.0	82092	10.5	1.064	0.288	
Elephant bull	14011	9.4	10821	13.9	3.144	0.002	-23
Elephant cow	74115	9.4	71275	12.0	0.509	0.611	
Elephant carcass 1	86	88.1	55	131.3	0.626	0.535	
Elephant carcass 2	186	47.0	226	53.1	0.532	0.595	
Elephant carcass 3	3209	13.5	1395	24.1	6.592	<0.001	-57
Elephant carcass 4	-	-	5175	10.3			
Elephant carcass all	3481	12.8	6850	9.4	8.492	<0.001	97

The statistical significance of changes in estimated number between 2001 (the year of the last nationwide elephant survey in Zimbabwe) and 2014 was determined using a two-tailed *t* test (Gasaway *et al* 1986). The percentage change in estimated number is given only if the change is statistically significant (i.e. $P < 0.05$).

Table 14. Population estimates and statistics for elephant, by administrative area, in regions surveyed from the air**Save Valley Conservancy**

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
SVC	1585	118	436828	84.9	239	2931	0.45

Gonarezhou

Area	Estimate	No. seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Park							
Gonarezhou NP	11120	1536	1910007	24.8	8367	13873	2.25
Safari Area							
Malapati SA	0	0	0	0.0	0	0	0
Communal Area							
Mahenye Ward	332	35	50558	156.2	35	851	1.50
Totals	11452	1571	1960565	24.3	8664	14240	2.14

North-west Matabeleland

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi SA / Kazuma Pan NP / Kazuma FA / Panda Masuie FA							
Kazuma Pan NP/FA	148	6	20164	305.3	6	600	0.27
Matetsi SA north	1551	74	1372172	178.6	74	4321	1.11
Matetsi SA south	3092	118	898709	75.0	772	5412	1.63
National Parks							
Hwange NP	45846	4579	10148869	13.8	39530	52162	3.02
Zambezi NP	52	3	2287	236.5	3	175	0.09
PWE subtotals	50689	4780	12442201	13.8	43701	57677	2.59
Communal Areas							
Maitengwe CA	733	25	423638	228.3	25	2406	0.61
Tsholotsho CA	1468	55	2017598	236.8	55	4944	0.78
CA subtotals	2201	80	2441236	163.7	80	5804	0.72
Forest Areas							
Ngamo Forest	1101	66	256606	108.8	66	2299	0.94
Sikumi Forest	0	0	0	0.0	0	0	0
FA subtotals	1101	66	256606	108.8	66	2299	0.47
NW Mat Totals	53991	4926	15140043	14.3	46280	61702	2.16

Zambezi Valley

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Park							
Mana Pools NP	2984	290	200209	30.2	2083	3885	1.38
Safari Areas							
Hurungwe SA	2698	291	338737	44.3	1503	3892	0.89
Sapi SA	578	53	32950	64.3	206	950	0.52
Chewore SA	3303	316	213376	28.7	2355	4251	1.00
Charara SA	36	7	577	156.3	7	93	0.02
Doma SA	153	24	7992	125.8	24	347	0.15
PWE subtotals	9753	981	793842	18.1	7983	11522	0.80
Communal Areas							
Guruve CA	1904	113	498874	77.1	435	3373	0.51
Mukwichi CA	0	0	0	0.0	0	0	0
CA subtotals	1904	113	498874	77.1	435	3373	0.47
Wilderness Area							
Mavuradonha WA	0	0	0	0.0	0	0	0
ZV Totals	11657	1094	1292716	19.4	9398	13915	0.69

Sebungwe

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Parks							
Chizarira NP	747	123	153003	107.8	123	1553	0.36
Matusadona NP	669	152	16387	39.0	408	929	0.49
Safari Areas							
Chirisa SA	1200	210	148332	65.9	410	1990	0.78
Chete SA	278	34	12884	84.9	42	514	0.22
PWE subtotals	2894	519	330605	39.7	1745	4043	0.46
Forest Area							
Sijarira Forest	16	2	75	132.2	2	37	0.06
Communal Areas							
North Gokwe CA	0	0	0	0.0	0	0	0.00
Binga CA	86	4	6872	247.8	4	299	0.03
Kariba CA	411	58	34558	92.0	58	790	0.13
CA subtotals	497	62	41430	82.9	85	910	0.06
Sebungwe Totals	3407	583	372110	35.6	2193	4622	0.22

Table 15. Population estimates and statistics for elephant bulls, by administrative area, in regions surveyed from the air**Save Valley Conservancy**

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
SVC	55	4	1825	166.3	4	147	0.02

Gonarezhou

Area	Estimate	No. seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Park							
Gonarezhou NP	1179	155	33284	31.3	811	1548	0.24
Safari Area							
Malapati SA	0	0	0	0.0	0	0	0
Communal Area							
Mahenye Ward	19	2	320	217.2	2	60	0.09
Totals	1198	157	33604	30.9	828	1569	0.22

North-west Matabeleland

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi SA / Kazuma Pan NP / Kazuma FA / Panda Masuie FA							
Kazuma Pan NP/FA	0	0	0	0.0	0	0	0
Matetsi SA north	43	4	1304	188.4	4	125	0.03
Matetsi SA south	155	7	5276	120.3	7	342	0.08
National Parks							
Hwange NP	5782	581	307725	19.1	4680	6884	0.38
Zambezi NP	0	0	0	0.0	0	0	0
PWE subtotals	5981	592	314305	18.6	4868	7093	0.31
Communal Areas							
Maitengwe CA	0	0	0	0.0	0	0	0.00
Tsholotsho CA	0	0	0	0.0	0	0	0.00
CA subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	250	15	55985	223.6	15	810	0.21
Sikumi Forest	0	0	0	0.0	0	0	0
FA subtotals	250	15	55985	223.6	15	810	0.11
NW Mat Totals	6231	607	370290	19.4	5022	7439	0.25

Zambezi Valley

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
National Park							
Mana Pools NP	1048	105	62478	48.1	544	1552	0.48
Safari Areas							
Hurungwe SA	705	73	33758	52.5	335	1075	0.23
Sapi SA	142	14	1631	57.8	60	225	0.13
Chewore SA	543	35	41885	80.4	106	979	0.16
Charara SA	36	7	577	156.3	7	93	0.02
Doma SA	0	0	0	0.0	0	0	0
PWE subtotals	2474	234	140329	30.1	1730	3219	0.20
Communal Areas							
Guruve CA	86	5	4410	215.1	5	270	0.02
Mukwichi CA	0	0	0	0.0	0	0	0.00
CA subtotals	86	5	4410	215.1	5	270	0.02
Wilderness Area							
Mavuradonha WA	0	0	0	0.0	0	0	0
ZV Totals	2560	239	144739	29.5	1804	3316	0.15

Sebungwe

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
National Parks							
Chizarira NP	97	16	4628	144.9	16	237	0.05
Matusadona NP	278	51	4851	52.8	131	425	0.20
Safari Areas							
Chirisa SA	139	25	3186	83.5	25	255	0.09
Chete SA	55	7	1407	143.3	7	135	0.04
PWE subtotals	569	99	14072	41.6	333	805	0.09
Forest Area							
Sijarira Forest	16	2	75	128.8	2	38	0.06
Communal Areas							
North Gokwe CA	0	0	0	0.0	0	0	0.00
Binga CA	86	4	6872	248.2	4	299	0.03
Kariba CA	105	10	9682	203.8	10	320	0.03
CA subtotals	191	14	16553	142.8	14	464	0.02
Sebungwe Totals	776	115	30700	45.4	424	1129	0.05

Table 16. Population estimates and statistics for elephants in cow herds, by administrative area, in regions surveyed from the air

Save Valley Conservancy

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
SVC	1529	114	435003	87.9	186	2873	0.44

Gonarezhou

Area	Estimate	No. seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Park							
Gonarezhou NP	9940	1381	1876723	27.5	7211	12670	2.01
Safari Area							
Malapati SA	0	0	0	0.0	0	0	0
Communal Area							
Mahenyne Ward	313	33	50238	164.9	33	830	1.42
Totals	10254	1414	1926961	27.0	7490	13018	1.92

North-west Matabeleland

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi SA / Kazuma Pan NP / Kazuma FA / Panda Masuie FA							
Kazuma Pan NP/FA	148	6	20164	305.4	6	600	0.27
Matetsi SA north	1509	70	1370868	183.5	70	4277	1.08
Matetsi SA south	2937	111	893433	78.8	624	5250	1.55
National Parks							
Hwange NP	40063	3998	9841144	15.5	33844	46283	2.64
Zambezi NP	52	3	2287	236.6	3	175	0.09
PWE subtotals	44709	4188	12127896	15.4	37810	51609	2.29
Communal Areas							
Tsholotsho CA	1468	55	2017598	236.8	55	4943	0.78
Maitengwe CA	733	25	423638	228.2	25	2407	0.61
CA subtotals	2201	80	2441236	163.7	80	5804	0.72
Forest Areas							
Ngamo Forest	851	51	200621	124.5	51	1910	0.72
Sikumi Forest	0	0	0	0.0	0	0	0
FA subtotals	851	51	200621	124.5	51	1910	0.36
NW Mat Totals	47761	4319	14769753	15.9	40143	55378	1.91

Zambezi Valley

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
National Park							
Mana Pools NP	1937	185	137731	38.6	1190	2684	0.89
Safari Areas							
Hurungwe SA	1993	218	304980	57.0	858	3128	0.66
Sapi SA	435	39	31319	83.3	73	798	0.39
Chewore SA	2760	281	171491	30.6	1914	3605	0.84
Charara SA	0	0	0	0.0	0	0	0.00
Doma SA	153	24	7992	125.8	24	347	0.15
PWE subtotals	7279	747	653513	22.1	5672	8886	0.59
Communal Areas							
Guruve CA	1819	108	494464	80.4	357	3281	0.48
Mukwichi CA	0	0	0	0.0	0	0	0
CA subtotals	1819	108	494464	80.4	357	3281	0.44
Wilderness Area							
Mavuradonha WA	0	0	0	0.0	0	0	0.00
ZV Totals	9098	855	1147977	23.4	6965	11231	0.54

Sebungwe

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
National Parks							
Chizarira NP	651	107	148374	122.0	107	1446	0.31
Matusadona NP	390	101	11536	56.2	171	610	0.29
Safari Areas							
Chirisa SA	1062	185	145146	73.8	278	1845	0.69
Chete SA	223	27	11477	99.5	27	446	0.18
PWE subtotals	2327	420	316533	48.4	1201	3452	0.37
Forest Area							
Sijarira Forest	0	0	0	0.0	0	0	0
Communal Areas							
North Gokwe CA	0	0	0	0.0	0	0	0.00
Binga CA	0	0	0	0.0	0	0	0.00
Kariba CA	307	48	24877	106.9	48	635	0.10
CA subtotals	307	48	24877	106.9	48	635	0.03
Sebungwe Totals	2633	468	341410	44.3	1468	3799	0.17

Table 17. Population estimates and statistics for elephant carcass 1, by administrative area, in regions surveyed from the air**Save Valley Conservancy**

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
SVC	0	0	0	0.0	0	0	0.00

Gonarezhou

Area	Estimate	No. seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Park							
Gonarezhou NP	0	0	0	0.0	0	0	0.00
Safari Area							
Malapati	0	0	0	0.0	0	0	0.00
Communal Area							
Mahenye Ward	0	0	0	0.0	0	0	0.00
Totals	0	0	0	0.0	0	0	0.00

North-west Matabeleland

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi SA / Kazuma Pan NP / Kazuma FA / Panda Masuie FA							
Kazuma Pan NP/FA	0	0	0	0.0	0	0	0.00
Matetsi SA north	0	0	0	0.0	0	0	0.00
Matetsi SA south	0	0	0	0.0	0	0	0.00
National Park							
Hwange NP	42	4	1111	165.2	4	112	0.003
Zambezi NP	0	0	0	0.0	0	0	0.00
PWE subtotals	42	4	1111	165.2	4	112	0.002
Communal Areas							
Tsholotsho CA	0	0	0	0.0	0	0	0.00
Maitengwe CA	0	0	0	0.0	0	0	0.00
CA 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
FA subtotals	0	0	0	0.0	0	0	0.00
NW Mat Totals	42	4	1111	165.2	4	112	0.002

Zambezi Valley

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Park							
Mana Pools NP	0	0	0	0.0	0	0	0.00
Safari Areas							
Hurungwe SA	0	0	0	0.0	0	0	0.00
Sapi SA	0	0	0	0.0	0	0	0.00
Chewore SA	0	0	0	0.0	0	0	0.00
Charara SA	0	0	0	0.0	0	0	0.00
Doma SA	0	0	0	0.0	0	0	0.00
PWE subtotals	0	0	0	0.0	0	0	0.00
Communal Areas							
Guruve CA	0	0	0	0.0	0	0	0.00
Mukwichi CA	0	0	0	0.0	0	0	0.00
CA subtotals	0	0	0	0.0	0	0	0.00
Wilderness Area							
Mavuradonha WA	0	0	0	0.0	0	0	0.00
ZV Totals	0	0	0	0.0	0	0	0.00

Sebungwe

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Parks							
Chizarira NP	7	1	49	217.4	1	22	0.003
Matusadona NP	0	0	0	0.0	0	0	0.00
Safari Areas							
Chirisa SA	5	1	20	182.2	1	15	0.003
Chete SA	0	0	0	0.0	0	0	0.00
PWE subtotals	12	2	69	141.1	2	29	0.002
Forest Land							
Sijarira Forest	0	0	0	0.0	0	0	0
Communal Areas							
North Gokwe CA	0	0	0	0.0	0	0	0.00
Binga CA	0	0	0	0.0	0	0	0.00
Kariba CA	0	0	0	0.0	0	0	0.00
CA subtotals	0	0	0	0.0	0	0	0.00
Sebungwe Totals	12	2	69	141.1	2	29	0.001

Table 18. Population estimates and statistics for elephant carcass 2, by administrative area, in regions surveyed from the air**Save Valley Conservancy**

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
SVC	0	0	0	0.0	0	0	0.00

Gonarezhou

Area	Estimate	No. seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Park Gonarezhou NP	0	0	0	0.0	0	0	0.00
Safari Area Malapati SA	0	0	0	0.0	0	0	0.00
Communal Area Mahenye Ward	0	0	0	0.0	0	0	0.00
Totals	0	0	0	0.0	0	0	0.00

North-west Matabeleland

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi SA / Kazuma Pan NP / Kazuma FA / Panda Masuie FA							
Kazuma Pan NP/FA	25	1	506	290.2	1	96	0.04
Matetsi SA north	34	2	548	152.6	2	86	0.02
Matetsi SA south	0	0	0	0.0	0	0	0.00
National Parks							
Hwange NP	63	5	1020	105.7	5	129	0.004
Zambezi NP	0	0	0	0.0	0	0	0
PWE subtotals	122	8	2074	76.9	28	215	0.01
Communal Areas							
Tsholotsho CA	0	0	0	0.0	0	0	0.00
Maitengwe CA	0	0	0	0.0	0	0	0.00
CA subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	0	0	0	0.0	0	0	0
Sikumi Forest	27	1	823	257.4	1	97	0.02
FA subtotals	27	1	823	257.4	1	97	0.01
NW Mat Totals	149	9	2897	73.9	39	259	0.01

Zambezi Valley

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Park							
Mana Pools NP	0	0	0	0.0	0	0	0.00
Safari Areas							
Hurungwe SA	0	0	0	0.0	0	0	0.00
Sapi SA	0	0	0	0.0	0	0	0.00
Chewore SA	0	0	0	0.0	0	0	0.00
Charara SA	13	1	182	236.5	1	45	0.01
Doma SA	0	0	0	0.0	0	0	0.00
PWE subtotals	13	1	182	236.5	1	45	0.001
Communal Areas							
Guruve CA	0	0	0	0.0	0	0	0.00
Mukwichi CA	0	0	0	0.0	0	0	0.00
CA subtotals	0	0	0	0.0	0	0	0.00
Wilderness Area							
Mavuradonha WA	0	0	0	0.0	0	0	0.00
ZV Totals	13	1	182	236.5	1	45	0.001

Sebungwe

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Parks							
Chizarira NP	15	2	117	149.3	2	37	0.01
Matusadona NP	0	0	0	0.0	0	0	0.00
Safari Areas							
Chirisa SA	48	9	342	80.9	9	88	0.03
Chete SA	0	0	0	0.0	0	0	0.00
PWE subtotals	64	11	459	69.2	20	107	0.01
Forest Land							
Sijarira Forest	0	0	0	0.0	0	0	0
Communal Areas							
North Gokwe CA	0	0	0	0.0	0	0	0
Binga CA	0	0	0	0.0	0	0	0
Kariba CA	0	0	0	0.0	0	0	0
CA subtotals	0	0	0	0.0	0	0	0
Sebungwe Totals	64	11	459	69.2	20	107	0.004

Table 19. Population estimates and statistics for elephant carcass 3, by administrative area, in regions surveyed from the air**Save Valley Conservancy**

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
SVC	27	2	337	140.3	2	65	0.01

Gonarezhou

Area	Estimate	No. seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Park							
Gonarezhou NP	90	10	759	62.3	34	146	0.02
Safari Area							
Malapati SA	0	0	0	0.0	0	0	0
Communal Area							
Mahenye Ward	0	0	0	0.0	0	0	0.00
Totals	90	10	759	62.3	34	146	0.02

North-west Matabeleland

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi SA / Kazuma Pan NP / Kazuma FA / Panda Masuie FA							
Kazuma Pan NP/FA	49	2	2240	305.4	2	200	0.09
Matetsi SA north	67	5	1535	126.0	5	151	0.05
Matetsi SA south	0	0	0	0.0	0	0	0.00
National Parks							
Hwange NP	797	69	19036	35.2	517	1077	0.05
Zambezi NP	17	1	244	231.6	1	57	0.03
PWE subtotals	930	77	23056	32.9	624	1236	0.05
Communal Areas							
Tsholotsho CA	0	0	0	0.0	0	0	0
Maitengwe CA	0	0	0	0.0	0	0	0.00
CA subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	17	1	292	242.2	1	57	0.01
Sikumi Forest	55	2	1479	172.5	2	149	0.05
FA subtotals	71	3	1771	136.2	3	168	0.03
NW Mat Totals	1001	80	24826	31.6	685	1318	0.04

Zambezi Valley

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
National Park							
Mana Pools NP	12	1	137	200.1	1	36	0.01
Safari Areas							
Hurungwe SA	0	0	0	0.0	0	0	0.00
Sapi SA	0	0	0	0.0	0	0	0.00
Chewore SA	0	0	0	0.0	0	0	0.00
Charara SA	5	1	29	236.5	1	18	0.003
Doma SA	0	0	0	0.0	0	0	0.00
PWE subtotals	18	2	166	150.6	2	44	0.001
Communal Areas							
Guruve CA	0	0	0	0.0	0	0	0.00
Mukwichi CA	0	0	0	0.0	0	0	0.00
CA subtotals	0	0	0	0.0	0	0	0.00
Wilderness Area							
Mavuradonha WA	0	0	0	0.0	0	0	0.00
ZV Totals	18	2	166	150.6	2	44	0.001

Sebungwe

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
National Park							
Chizarira NP	24	4	165	112.1	4	50	0.01
Matusadona NP	28	5	83	70.1	8	47	0.02
Safari Areas							
Chirisa SA	160	26	1554	50.2	80	240	0.10
Chete SA	18	2	155	149.9	2	44	0.01
PWE subtotals	229	37	1958	38.9	140	318	0.04
Forest Area							
Sijarira Forest	8	1	50	209.9	1	25	0.03
Communal Areas							
North Gokwe CA	16	2	85	132.2	2	36	0.01
Binga CA	0	0	0	0.0	0	0	0.00
Kariba CA	6	1	38	238.6	1	21	0.002
CA subtotals	22	3	123	108.6	3	45	0.002
Sebungwe Totals	259	41	2130	35.7	166	351	0.02

Table 20. Population estimates and statistics for elephant carcass 4, by administrative area, in regions surveyed from the air**Save Valley Conservancy**

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
SVC	40	3	457	110.9	3	85	0.01

Gonarezhou

Area	Estimate	No. seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
National Park							
Gonarezhou NP	421	53	3795	29.1	298	543	0.09
Safari Area							
Malapati SA	10	1	84	212.3	1	30	0.05
Communal Area							
Mahenye Ward	0	0	0	0.0	0	0	0
Totals	430	54	3879	28.8	307	554	0.08

North-west Matabeleland

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ⁻²)
Matetsi SA / Kazuma Pan NP / Kazuma FA / Panda Masuie FA							
Kazuma Pan NP/FA	99	4	1319	117.2	4	214	0.18
Matetsi SA north	324	23	3839	41.0	191	457	0.23
Matetsi SA south	103	5	2566	113.0	5	220	0.05
National Parks							
Hwange NP	2015	196	28384	16.6	1681	2348	0.13
Zambezi NP	104	6	2988	135.2	6	244	0.19
PWE subtotals	2645	234	39096	14.8	2254	3036	0.14
Communal Areas							
Tsholotsho CA	0	0	0	0.0	0	0	0
Maitengwe CA	0	0	0	0.0	0	0	0.00
CA subtotals	0	0	0	0.0	0	0	0.00
Forest Areas							
Ngamo Forest	117	7	2533	101.9	7	236	0.10
Sikumi Forest	109	4	5205	161.8	4	286	0.09
FA subtotals	226	11	7739	85.7	32	420	0.10
NW Mat Totals	2871	245	46834	14.9	2443	3299	0.12

Zambezi Valley

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
National Park							
Mana Pools NP	152	13	2319	65.6	52	251	0.07
Safari Areas							
Hurungwe SA	197	19	1494	39.8	118	275	0.07
Sapi SA	62	4	939	107.6	4	128	0.06
Chewore SA	160	10	3077	72.1	45	275	0.05
Charara SA	5	1	29	236.5	1	18	0.003
Doma SA	0	0	0	0.0	0	0	0
PWE subtotals	575	47	7858	30.7	399	752	0.05
Communal Areas							
Guruve CA	117	8	1832	77.9	26	208	0.03
Mukwichi CA	0	0	0	0.0	0	0	0
CA subtotals	117	8	1832	77.9	26	208	0.03
Wilderness Area							
Mavuradonha WA	0	0	0	0.0	0	0	0
ZV Totals	693	55	9689	28.2	497	888	0.04

Sebungwe

Area	Estimate	No. Seen	Variance	% CI	Lower CL	Upper CL	Density (km ²)
National Park							
Chizarira NP	372	53	5440	40.7	221	524	0.18
Matusadona NP	87	17	390	47.2	46	128	0.06
Safari Areas							
Chirisa SA	335	56	2823	32.2	227	443	0.22
Chete SA	75	9	295	47.6	39	111	0.06
PWE subtotals	869	135	8948	21.8	680	1059	0.14
Forest Area							
Sijarira Forest	57	7	209	61.5	22	93	0.22
Communal Areas							
North Gokwe CA	23	3	127	107.4	3	48	0.01
Binga CA	62	3	2336	170.8	3	167	0.02
Kariba CA	129	17	1190	54.1	59	199	0.04
CA subtotals	214	23	3653	57.8	90	338	0.02
Sebungwe Totals	1141	165	12811	19.7	916	1366	0.07

Table 21. Elephant carcass ratios, by administrative area, in regions surveyed from the air

Save Valley Conservancy

Area	1+2 carcass ratio (elephant carcasses in age category 1 or 2)	All-carcass ratio (all elephant carcasses)	All-carcass ratio (all elephant carcasses and unidentified carcasses)
SVC	0.00	4.3	8.9

Gonarezhou

Area	1+2 carcass ratio (elephant carcasses in age category 1 or 2)	All-carcass ratio (all elephant carcasses)	All-carcass ratio (all elephant carcasses and unidentified carcasses)
National Park Gonarezhou NP	0	4.4	6.6
Safari Area Malapati SA	-	100.0	100.0
Communal Area Mahenye Ward	0	0	0
Totals	0.00	4.3	6.6

North-west Matabeleland

Area	1+2 carcass ratio (elephant carcasses in age category 1 or 2)	All-carcass ratio (all elephant carcasses)	All-carcass ratio (all elephant carcasses and unidentified carcasses)
Matetsi SA / Kazuma Pan NP / Kazuma FA / Panda Masuie FA			
Kazuma Pan NP/FA	14.28	53.8	53.8
Matetsi SA north	2.16	21.5	24.1
Matetsi SA south	0.00	3.2	5.8
National Parks			
Hwange NP	0.23	6.0	6.8
Zambezi NP	0.00	70.0	70.0
PWE subtotals	0.32	6.9	7.8
Communal Areas			
Tsholotsho CA	0.00	0.0	1.8
Maitengwe CA	0.00	0.0	3.8
CA subtotals	0.00	0.0	2.5
Forest Areas			
Ngamo Forest	0.00	10.8	10.8
Sikumi Forest	100.00	100.0	100.0
FA subtotals	2.42	22.8	28.3
NW Mat Totals	0.35	7.0	8.2

Zambezi Valley

Area	1+2 carcass ratio (elephant carcasses in age category 1 or 2)	All-carcass ratio (all elephant carcasses)	All-carcass ratio (all elephant carcasses and unidentified carcasses)
National Park			
Mana Pools NP	0.00	5.2	5.2
Safari Areas			
Hurungwe SA	0.00	6.8	7.4
Sapi SA	0.00	9.6	9.6
Chewore SA	0.00	4.6	4.6
Charara SA	27.05	40.0	54.3
Doma SA	0.00	0.0	0.0
PWE subtotals	0.14	5.9	6.2
Communal Areas			
Guruve CA	0.00	5.8	5.8
Mukwichi CA	-	-	-
CA subtotals	0.00	5.8	5.8
Wilderness Area			
Mavuradonha WA	-	-	-
ZV Totals	0.12	5.8	6.1

Sebungwe

Area	1+2 carcass ratio (elephant carcasses in age category 1 or 2)	All-carcass ratio (all elephant carcasses)	All-carcass ratio (all elephant carcasses and unidentified carcasses)
National Park			
Chizarira NP	2.85	35.9	45.6
Matusadona NP	0.00	14.6	15.2
Safari Areas			
Chirisa SA	4.29	31.4	35.6
Chete SA	0.00	25.0	29.9
PWE subtotals	2.55	28.9	34.5
Forest Area			
Sijarira Forest	0.00	80.4	82.2
Communal Areas			
North Gokwe CA	-	100.0	100.0
Binga CA	0.00	41.8	48.1
Kariba CA	0.00	24.8	51.0
CA subtotals	0.00	32.2	53.4
Sebungwe Totals	2.17	30.2	38.9